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NOTICE

Superintendents' Question Box

For many years in the past it has been the practice to report quite fully in the Journal and to discuss at considerable length at annual convention meetings, a series of topics of interest to superintendents. These topics have generally been listed under the "Superintendents' Question Box Series." In the preparation of programs for annual sessions, the Publication Committee is frequently at a loss to determine which of the questions ordinarily discussed are of greater interest than others to the superintendents.

It would be decidedly helpful, therefore, if all those persons interested in these particular topics would communicate promptly with the undersigned in order to assist him in the choice of question box topics which would supply most completely the requirements of the superintendents' group.

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VOL. 18 DECEMBER, 1927 No. 6

THE WATER SUPPLY PROJECT OF THE MAHONING VALLEY SANITARY DISTRICT[1]

BY W. H. DITTOE[2]

In many of the metropolitan areas of the United States and other countries the organization of districts has been adopted as an advantageous means of providing public improvements of wide variety, including water supply, sewerage, sewage disposal, drainage, flood protection, parks and other projects. Of the earlier districts organized in this country mention may be made of the Boston Metropolitan Water and Sewerage Districts and the Sanitary District of Chicago formed about 1890 to 1895. During the past twenty-five years the district plan of procedure has received impetus and many organizations have been effected for a variety of purposes. Some of those more recently formed are the Washington Suburban Sanitary District, The Miami Conservancy District (Ohio) for flood protection, The New Jersey Water Supply Districts, the various Illinois Sanitary Districts and the several municipal utility districts of California. The Winnipeg, Vancouver and Essex Border Districts in Canada should also be cited.

In Ohio legislative authority was given in 1919 for the formation of sanitary districts for purposes of water supply and sewage disposal,

[1] Presented before the Central States Section meeting, September 15, 1927.

[2] Chief Engineer, The Mahoning Valley Sanitary District, Youngstown, Ohio.

by enactment of the Sanitary District Act of Ohio, and The Mahoning Valley Sanitary District, organized February, 1926, is the first major undertaking pursuant to this law.

This district comprises the cities of Youngstown and Niles, having present estimated populations of 162,700 and 17,900 respectively and was formed for the purpose of providing a satisfactory public water supply for their joint use. The work of the District, preliminary to construction, has been in progress for the past 15 months during which extensive investigations have been conducted and a plan of water supply prepared, which has recently been submitted to the Board of Directors of the District. It is expected that construction will be undertaken in the spring of 1928.

The purpose of this paper is to explain briefly the conditions leading to the establishment of the District, the provisions of the Sanitary District Act controlling the procedures followed and the general features of the recommended plan.

CONDITIONS LEADING TO THE ESTABLISHMENT OF THE DISTRICT

"The Mahoning Valley" is a term commonly used to designate the intensively developed industrial district extending along the Mahoning River from the Pennsylvania State Line upstream to Newton Falls a distance of about 42 miles. Within this zone are nine municipalities, with a total population of 250,000, of which Youngstown, Niles and Warren are the most important.

The Mahoning Valley has attained its rank as one of the leading population centers of Ohio by reason of the growth which has attended the development of the iron and steel industry, its outstanding activity.

All of the sewage from the municipalities and other sewered areas of the valley reaches the Mahoning River without treatment and practically all industrial wastes are similarly disposed of. The river water is used extensively for cooling and condensing purposes, a total of approximately 800 million gallons daily being pumped and repumped from the stream representing $8\frac{1}{2}$ times the minimum flow available with present facilities for river regulation furnished by the Milton Reservoir. As a result the Mahoning River, draining an area of about 1000 square miles in Ohio, is grossly polluted, especially at points downstream from Warren, below which the valley is almost continuously occupied by industrial, residential and commercial development. In spite of its condition the river serves as a source

of public water supply for Warren, Niles and Youngstown, the three principal cities of the valley, each of which operates a filtration plant in the attempt to render the river water suitable for use. Above Warren the pollution of the river is less intense than below, and thus far the water supply of that city has not been affected to a degree necessitating remedy. At Niles and Youngstown, however, the condition of the river supply has become so bad that it is impossible to produce a satisfactory water notwithstanding unusually resourceful operation of the filtration plants, at both of which lime is used in amounts to produce causticity. The final product as delivered to consumers is of high degree of hardness, due principally to industrial wastes, of offensive taste and odor reflecting the gross pollution of the source, and of abnormal temperature during the warmer dry weather months of the year due to extensive use of their river water for cooling purposes. The water is not only unsuitable for drinking and other domestic uses, but causes rapid depreciation of plumbing, piping, heating systems and boilers by both incrustation and corrosion. Moreover, while the lime treatment has thus far been successful in coping with the excessive bacterial load and while typhoid fever has been of rare occurrence recently in Youngstown and Niles, no factor of safety exists and there is the ever present possibility of explosive outbreak of waterborne disease resulting from accidental interruption or failure of the treatement process.

An urgent popular demand for a satisfactory water supply has existed in both Youngstown and Niles for many years and both cities have made previous investigations of possible means of improvement of their respective supplies. It was not until the enactment of the Sanitary District Act in 1919 however that a definite impetus was given to the project of providing a remedy for the present unsatisfactory conditions. The passage of this law afforded for the first time the possibility of joint action of the two municipalities in the solution of their common water supply problem and after full consideration of the various questions involved conclusion was reached by the officials and representative citizens of each city that this common problem would best be solved through formation of a District. Initiative action was therefore taken by the city councils and citizens of Youngstown and Niles in the submission of a petition to the Court of Common Pleas of Mahoning County, upon the hearing of which the Court on February 2, 1926, ordered the formation of the District for the purpose of providing a satisfactory public water supply for the two municipalities.

PROVISIONS OF LAW

The Sanitary District Act of Ohio, which is of general application throughout the State, permits the organization of districts, including two or more political subdivisions or parts thereof for either or both of the following purposes: (a) improved water supply and (b) improved sewage disposal. As The Mahoning Valley Sanitary District was formed solely for the purpose of improved water supply only the provisions of the law applicable to this purpose will be discussed.

No municipality may be included in a District for water supply unless petition is made by the governing body or by the water company which may be supplying water under franchise. Such petition is heard by the Court of Common Pleas, a joint court being formed in case two or more counties are involved, and, upon finding being made organizing the District, it becomes a political subdivision of the State for the purpose of its establishment. The Court appoints a Board of Directors to manage the affairs of the District and a Board of Appraisers to appraise values of property to be acquired and damages and benefits which will result from the improvement. The Board of Directors is required to prepare a plan which is subject to hearing and review by the Court. The Board of Appraisers must submit a report of its findings to the Court, for approval, opportunity being given for full hearing of any objections thereto. It is required that the value of benefits resulting from the improvement, as reported by the Appraisers and approved by the Court, be at least equal to the estimated cost.

After court approval of the appraisal and plan the Board of Directors is authorized to levy assessments upon benefited units and to issue and sell District bonds in anticipation of collection of such assessments. Annual assessment levies are provided for to produce the amounts required each year for interest and amortization. The law requires that assessments must be levied upon the benefited units in proportion to the benefits appraised and not in excess thereof.

In the case of The Mahoning Valley Sanitary District it is proposed to assign all benefits to the two member cities as such and to avoid appraisal of benefits to individual properties within each city. The assessments will thus be made on each city as a unit and in accordance with the Sanitary District Act each city is empowered to collect a special tax levy to secure the amount necessary to meet each annual installment.

When funds are secured from the sale of bonds or from loans made in anticipation thereof, the Board of Directors is empowered to acquire land and to proceed with construction, either directly or by award of contracts in the usual manner. Ample power to carry out the purposes of the District is conferred upon the Board.

After the works have been constructed it is the duty of the Board of Directors to maintain and operate them. Funds for this purpose are to be secured by sale of water to the member municipalities at uniform rates to be adjusted from time to time to produce the necessary income.

THE PLAN FOR THE DISTRICT WATER SUPPLY

Preliminary to the preparation of the recommended plan a thorough canvass was made of all sources of supply within reasonable reach of the District and it was found that the best and most economical water supply would be secured by development of Meander Creek, a tributary of the Mahoning River, constructing a dam and forming a large storage reservoir for regulating of the supply. Following selection of this source a thorough study was made of the several means by which the chosen supply might be delivered to the District including (a) delivery of raw water to the existing plants and (b) provision of complete new District purification and pumping works so as to deliver purified water to the member cities. It was concluded that the individual interests of Youngstown and Niles and the purpose of formation of the District would best be served, with greatest ultimate economy, by the delivery of purified water from the Meander Creek supply.

In accordance with the major conclusions resulting from the preliminary investigations, the recommended plan of water supply for the District provides for the development of Meander Creek, the purification of this supply at the source and delivery of the purified supply by pumping to the present distributing systems of Youngstown and Niles.

The essential features of the plan include:

1. The Meander Creek Reservoir formed by the construction of the Mineral Ridge dam.
2. Purification and pumping works located immediately below the dam.
3. Pipe lines for delivery of the purified supply to the two cities.
4. A covered distributing reservoir in Youngstown and a steel standpipe in Niles, for reserve storage of water on the distributing systems.

The cost of execution of this plan is estimated at $9,150,000 made up of the following principal elements:

Dam and reservoir	$3,781,960
Purification and pumping works	2,310,030
Pipe lines and distributing reservoir for Youngstown	2,661,600
Pipe lines and standpipe for Niles	396,410

Meander Creek which enters the Mahoning River from the south at Niles drains an area of about 90 square miles which is mainly a rolling farm country containing a population of 55 persons per square mile and no serious sources of pollution by sewage or industrial wastes. This stream is at a much shorter distance from the center of consumption of the District than any of the other sources considered. The Mineral Ridge dam site in air line distance is about 7.8 miles westerly from the center of Youngstown and about 2 miles southerly from the center of Niles.

The dam will be of the earth embankment type with concrete core wall, separated into two wings by a massive concrete spillway 50 feet in height with crest at elevation 905. The overall length of the dam will be 3550 feet and the spillway will have a clear width of 260 feet giving it a capacity, with water level 7 feet above the crest, of 18,000 cubic feet per second or 208 cubic feet per second per square mile of drainage area.

The reservoir at spillway elevation will cover 2010 acres, will extend approximately 7 miles upstream from the dam and will have a maximum width of about one mile. Its available content above elevation 875 is 10 billion gallons. The safe yield is estimated at 0.43 million gallon daily per square mile of drainage area or 37.4 million gallons daily. This yield is adequate for the needs of the District until 1950. Opportunity for economical future increase of the supply available at this point to a total of 76.4 million gallons daily—sufficient for at least fifty years—is offered by reservoir development on the Upper Mahoning River with provision of a tunnel 8.7 miles long to deliver the additional supply into the Meander Creek Basin.

The highway changes to be made in connection with the reservoir include two viaduct crossings and two border roads, the overall lengths of which total 4.4 miles. One of the viaducts is to be a nine-span concrete arch bridge 894 feet in length while the other is designed as a six-span concrete beam bridge 260 feet in length.

The design of the purification plant provides for softening and rapid sand filtration. It is proposed to reduce the hardness of the water from an average of 135 parts per million to 100 parts or less. The plant will have initial rated capacity of 42 m.g.d. sufficient for a daily average supply of 32 million gallons with the distribution storage to be provided. The works are laid out for enlargement to capacity suitable for a daily output of 80 million gallons. Ordinarily the water will flow by gravity from the storage reservoir through the plant, but low lift pumps are included for occasional necessary operation.

The chemical house is designed for handling and storing of bulk chemicals and application through dry feed machines. The upper portion of this building will contain 10 concrete storage bins with total capacity of 700 tons, equivalent to six weeks supply of chemicals for a plant output of 40 m.g.d. Mixing chambers in four units equipped with motor driven agitators will provide a 20-minute mixing period.

Covered coagulation basins, of concrete groined arch construction, will furnish a settling period of 4 hours. Before passing to the filters carbon dioxide gas will be applied to the water to prevent lime incrustation. Two chambers adjacent to the coagulation basins will be provided for this purpose, furnishing a retention period of 10 minutes.

The filters will be in 14 units of 3 million gallons daily capacity each, constructed in a double row over concrete clear wells of one million gallons available storage capacity with pipe gallery between. A steel wash water tank of 130,000 gallons capacity will be enclosed in the filter building.

The pumping station is designed for use of steam-turbine-driven centrifugal pumping equipment. The initial installation will include one low-lift pump of 25 m.g.d. capacity for occasional operation and three high-lift units, two of 25 and one of 17.5 m.g.d. capacity, for service in pumping the supply to Youngstown and Niles in common. The initial boiler installation will include three stoker-fired units of 500 horsepower each, with provision of coal storage and equipment for mechanical handling of coal and ashes. The boiler room will also house the equipment for production of carbon dioxide gas.

The purified supply will be delivered to Youngstown in duplicate force mains, 36 inches in diameter and about 28,000 feet long, extending southeasterly from the pumping station to the distributing reservoir in the extreme westerly portion of the city. Two feeder

mains, each 36 inches in diameter and about 13,000 feet in length, will connect the force mains and the distributing reservoir with the existing large mains of the low service distributing system of the city.

The Youngstown distributing reservoir of 30 million gallons capacity will be of concrete groined arch construction.

The Niles force mains in duplicate will be 20 inches in diameter, one 10,000 feet in length and the other 15,000 feet long, connecting the pumping station with the present distributing system of the city. The Niles standpipe, replacing the present distributing reservoir, will be 60 feet in diameter and 70 feet in height with a capacity of 1.5 million gallons.

Upon completion of the proposed works the use of the existing filtration plants at Youngstown and Niles will be discontinued. The existing Youngstown pumping station will be retained as a booster station to draw water under pressure from the low-service mains and discharge to high-service. No repumping at Niles will be necessary.

With the execution of the recommended plan the member cities of the District will be provided with a water of high standard of quality —pure, attractive, wholesome and soft—meeting all modern requirements in a water supply. Important savings will be realized in the household and commercial use of water of such quality as compared with the existing unsatisfactory supplies, involving reduction in cost of soap and softening compounds, in depreciation of fabrics in laundering, in repair and replacement of plumbing and heating systems and in other items. Upon a most conservative basis of estimate, the total of such savings effected within the period of bond retirement will exceed the cost of execution of the plan. It may be mentioned that such savings form a rational basis of estimate of the benefits resulting from the improvement.

Associated with the writer in the direction of the engineering work of the District, G. Gale Dixon, Deputy Chief Engineer, has been in direct charge of office studies and design and C. B. Cornell, Field Engineer, has directed all field work.

ADVANTAGES OF DISTRICT PROCEDURE

Many valid arguments have been advanced in favor of District organization for solution of major water supply problems of important population centers. The growth of large cities is usually attended by growth and development of adjacent municipalities and

as a result the water supply problem becomes complex. Independent supplies are uneconomical and are frequently impossible to secure. In many instances the largest or outstanding municipality is placed at a disadvantage in shouldering the burden of investments for works adequate for all.

There is distinct advantage to be gained by joint action. Increased financial resources make larger and more satisfactory projects feasible, frequently at less cost than would be involved in individual action. Conflict between municipalities over water rights is eliminated; duplication of effort with the attendant expense is avoided; and all benefits of centralized control of construction and operation accrue.

The project of The Mahoning Valley Sanitary District has progressed sufficiently to warrant the belief that all the advantages claimed for District procedure will be realized by the member cities. The further progress of work of this District will no doubt be observed with interest by other cities having similar problems.

DESIGN OF PERFORATED PIPE STRAINER SYSTEM[1]

By J. W. Ellms[2]

The perforated lateral pipe and center manifold strainer system for rapid sand filters is one of the older systems in common use. It has certain advantages that commend it to engineers and, when properly designed, has generally given good results in practice. Some experimental work on the hydraulics of such a system, undertaken some years ago, may be of interest to engineers.

The experiments carried on in 1920 at Sacramento, California, by H. N. Jenks, Assistant Engineer of the Filtration Division of the City Water Department, were for the purpose of determining the proper relation between the size and spacing of perforations and the size and length of the lateral pipe in this type of underdrain system. The relative cross sectional areas of different sized perforations and of various sized laterals were studied thoroughly and some important deductions made. The conclusions reached by Mr. Jenks in this study were as follows:

1. The ratio of the length of the lateral to its diameter expressed in inches should not exceed 60.
2. The diameter of perforations in the lateral should be between $\frac{1}{4}$- and $\frac{1}{2}$-inch.
3. The spacing of the perforations along the lateral may vary from 3 inches, for a diameter of perforation of $\frac{1}{4}$ inch, to 8 inches for a diameter of perforation of $\frac{1}{2}$ inch.
4. The ratio of the total area of the perforations in the underdrain system to the total cross sectional area of the laterals should not exceed 0.5 for a diameter of perforation of $\frac{1}{2}$ inch, and should decrease to 0.25 for a diameter of perforation of $\frac{1}{4}$ inch.
5. The ratio of the total area of the perforations in the underdrain system to the entire filter area may be as low as 0.002 or 0.3 square inch per square foot of filter.
6. The spacing of the laterals may be as great as 12 inches for satisfactory diffusion, but is limited by the total head available.

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[1] Presented before the Central States Section meeting, September 21, 1926.

[2] Engineer of Water Purification and Sewage Disposal, Department of Public Utilities, Division of Water, Cleveland, Ohio.

7. The rate of washing may be varied from 6 to 36 inches per minute, or 0.5 to 3.0 cubic feet per square foot of filter per minute, provided the foregoing factors are used in the design.

The experiments at Sacramento were confined to the relation between the perforations and the laterals and showed that it was possible to obtain a fairly uniform discharge from the perforations, if there was a proper ratio between the sum of the cross sectional areas of the perforations and the cross sectional area of the lateral. It seemed to the writer that to make this investigation complete, it was desirable to go one step further and determine the proper relation between the sum of the cross sectional areas of the laterals and the cross sectional area of the header or manifold.

The Sacramento experiments indicated, also, that with a correct spacing of the perforations in the lateral, much longer laterals might be employed than have been the custom heretofore. In consequence, it occurred to the writer that, if a correct ratio of the sum of the cross sectional areas of the laterals to the header or manifold could be found, it might be possible to take advantage of the longer laterals by using one header or manifold in place of two, as is usually the case in large filter units, and utilize a much longer lateral that would extend from the center gutter to the opposite wall of the filter tank. If this could be done, it would be possible to place one main header under the bottom of the center gutter, and from this header or manifold extend long laterals across the entire width of each half of the filter bed, thus doing away with the usual manifold for each half of the filter tank.

The common practice in building large filter units of placing a manifold in each half of the tank is objectionable, in that it produces, on account of its width and depth, more or less of a dead area over each manifold that is not properly washed. The manifold as a rule stands several inches higher than the laterals. The placing of perforations or strainer nozzles in the top of the manifold or perforations in the bottom is a makeshift that does not produce the desired washing effect. The gravel bed must also be deeper on account of these center manifolds, and wash water rising from the laterals must meet more resistance than that which rises from the perforations or nozzles in the top of the manifold.

For these reasons it seemed desirable to learn whether the use of one large manifold, placed under the center gutter where it could not blanket any portion of the filter bed, and with long laterals ex-

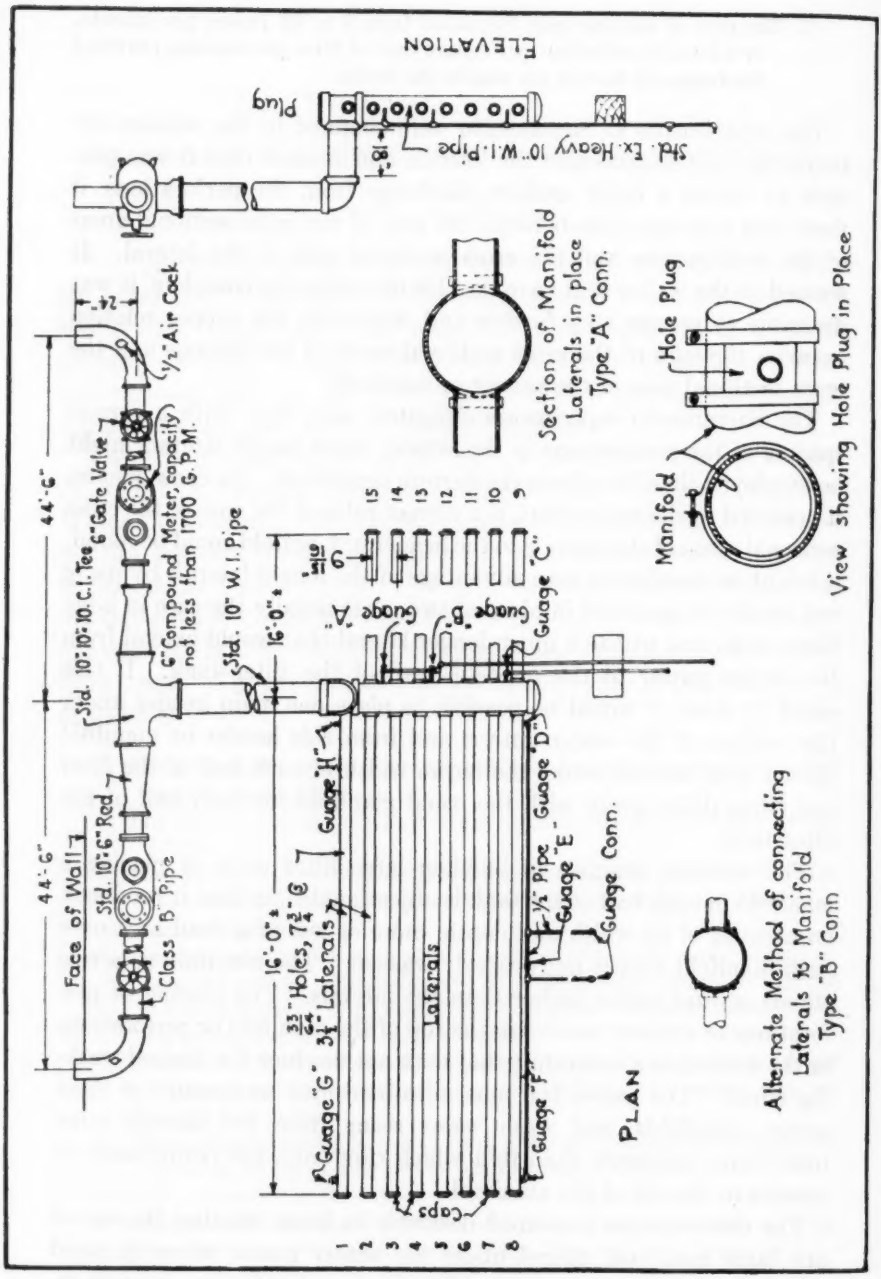

FIG. 1. EXPERIMENTAL STRAINER SYSTEM

tending across each half of the bed, was not feasible from the hydraulic standpoint. Such a change would result in decreasing the total amount of piping, and also in providing a better and more effective washing of the filter bed. With these objects in mind, the experimental strainer pipe layout was designed and constructed. It is shown in figure 1 and may be briefly described as follows.

TABLE 1

Total areas and ratios of areas

	DIAMETER	CROSS SECTIONAL AREA
	inches	*square inches*
1. Manifold or header	10	74.66
2. One lateral	$3\frac{1}{2}$	9.89
3. One perforation	$\frac{33}{64}$	0.209
4. Twenty-three perforations in one lateral-total area (23×0.209)		4.81

Ratios

	NUMBER OF LATERALS			
	A	B	C	D
For 14 laterals	0.48 to 1	1.85 to 1	0.90 to 1	0.54 to 1
For 12 laterals	0.48 to 1	1.60 to 1	0.77 to 1	0.63 to 1
For 10 laterals	0.48 to 1	1.33 to 1	0.64 to 1	0.75 to 1
For 8 laterals	0.48 to 1	1.06 to 1	0.51 to 1	0.94 to 1
For 6 laterals	0.48 to 1	0.80 to 1	0.39 to 1	1.26 to 1
For 4 laterals	0.48 to 1	0.53 to 1	0.26 to 1	1.88 to 1

Ratio A. Area of perforations in one lateral to cross sectional area of one lateral.

Ratio B. Sum of cross sectional areas of "n" laterals to cross sectional area of 10-inch diameter header.

Ratio C. Sum of cross sectional areas of perforations in "n" laterals to cross sectional area of 10-inch diameter header.

Ratio D. Cross sectional area of 10-inch diameter header to sum of cross sectional areas of "n" laterals.

The experimental strainer system consisted of a header or manifold 10 inches in diameter, and two sets of lateral pipes placed opposite each other in the same plane. The laterals were screwed into saddle flanges welded to the sides of the header and opening into the latter through a hole cut in the side of the 10-inch pipe. This method of

FIG. 1. EXPERIMENTAL STRAINER SYSTEM

connecting the laterals to the header differs somewhat from the drawing, but was changed for construction reasons.

The laterals were each 3½ inches in diameter, and spaced 9 1/16 inches apart on centers. The perforations in the laterals were 3/4 inch in diameter, and were spaced on 7¾ inches centers. From the center of the header to the end of the laterals was approximately 16 feet. The laterals were turned so as to have the perforations at the top in order to measure the height to which the jets of water rose. Meters were provided for measuring the total flow of water for the different rates studied.

Gages for loss of head were provided at the four corners of the grid of laterals and also at different points on the main header. Gage boards placed at convenient points permitted reading the average height to which the water rose in the various tests.

In table 1 a tabulation of some of the basic data of the design for this experimental strainer system, as well as certain ratios used in the discussion of the results are presented.

The design follows the recommendations of H. N. Jenks as a result of his work in Sacramento in so far as the relation of the diameter and spacing of the perforations to the diameter and length of the laterals is concerned. By removing laterals, it was possible to change the ratio of the cross sectional area of the manifold to the sum of the cross sectional areas of the laterals. It was recognized that with 14 or 15 laterals in place the header would be too small to feed them; but by reducing the number of laterals, it would be possible to bring the ratios within reasonable limits. The ratios in the table for 14, 12, 10, 8, 6 and 4 laterals indicate the effect of reducing the number of laterals. The volume of water for rises of 20, 22, 24, 26, 27, 28, 29 and 30 inches per minute was reduced in proportion as the number of laterals were reduced in order to maintain a proper relation between the number of laterals and the area which they would serve. The area of filter nominally represented by full number of laterals was 172.4 square feet. The volume of water required for the different rates of washing varied from 77 to 432 cubic feet per minute, depending upon the number of laterals in operation.

In figures 2 to 7 inclusive, gage readings showing the height to which the water rose at the four corners of one-half the lateral pipe grid are shown. These gages, marked on figure, indicated the losses of head between the various points and showed that there was not a complete conversion of velocity head into static head. In general,

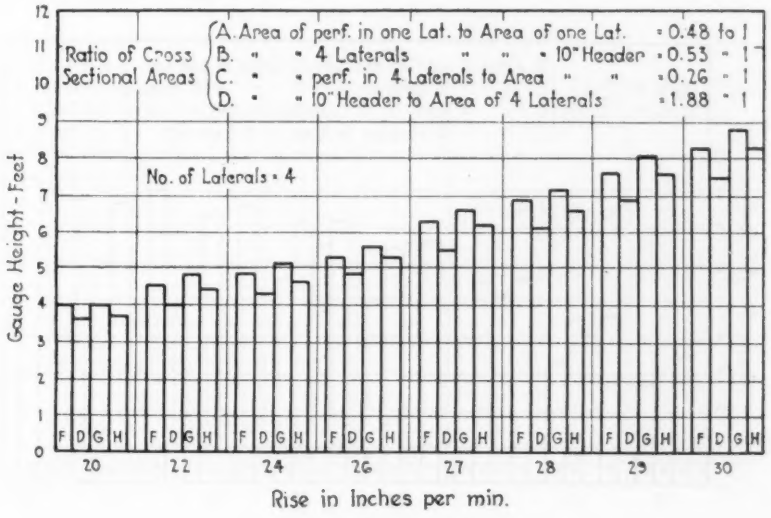
Ratio of Cross Sectional Areas
A. Area of perf. in one Lat. to Area of one Lat. = 0.48 to 1
B. " " 4 Laterals " " " 10" Header = 0.53 " 1
C. " " perf. in 4 Laterals to Area " " = 0.26 " 1
D. " " 10" Header to Area of 4 Laterals = 1.88 " 1
No. of Laterals = 4
Gauge Height - Feet
F D G H
20 22 24 26 27 28 29 30
Rise in Inches per min.

FIG. 2

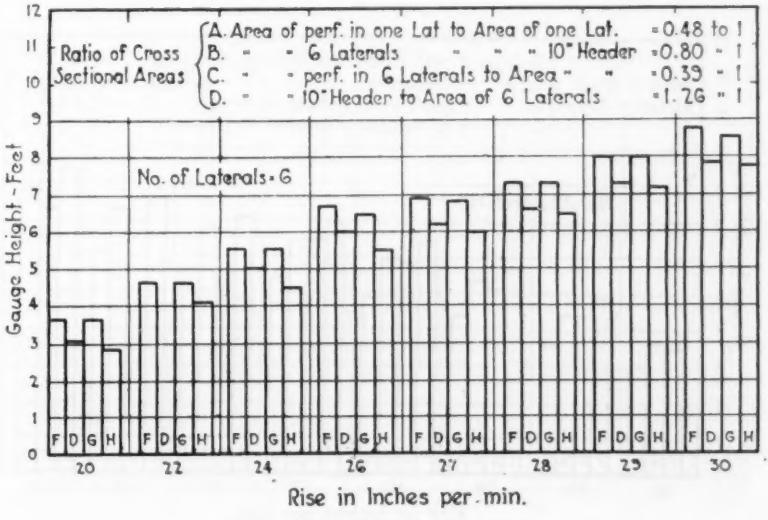
Ratio of Cross Sectional Areas
A. Area of perf. in one Lat to Area of one Lat. = 0.48 to 1
B. " " 6 Laterals " " " 10" Header = 0.80 " 1
C. " " perf. in 6 Laterals to Area " " = 0.39 " 1
D. " " 10" Header to Area of 6 Laterals = 1.26 " 1
No. of Laterals = 6
Gauge Height - Feet
F D G H
20 22 24 26 27 28 29 30
Rise in Inches per min.

FIG. 3

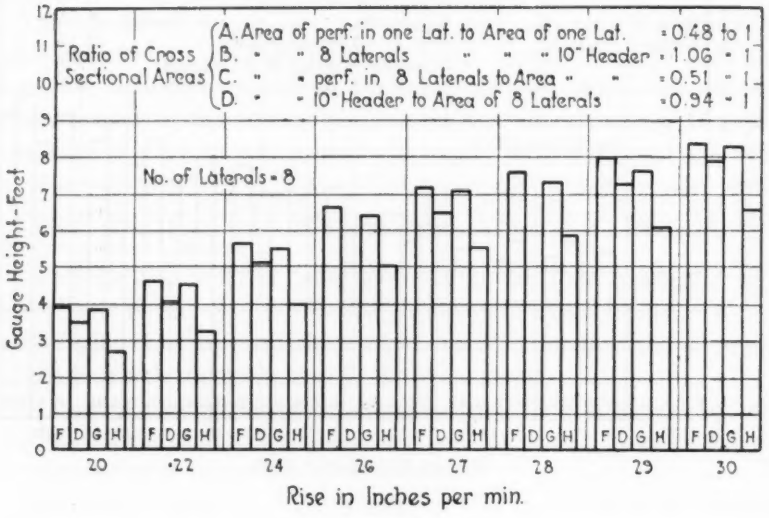
Ratio of Cross Sectional Areas
A. Area of perf. in one Lat. to Area of one Lat. = 0.48 to 1
B. " " 8 Laterals " " " 10" Header = 1.06 = 1
C. " " perf. in 8 Laterals to Area " " = 0.51 = 1
D. " " 10" Header to Area of 8 Laterals = 0.94 = 1
No. of Laterals = 8
Gauge Height - Feet
F D G H
20 22 24 26 27 28 29 30
Rise in Inches per min.

FIG. 4

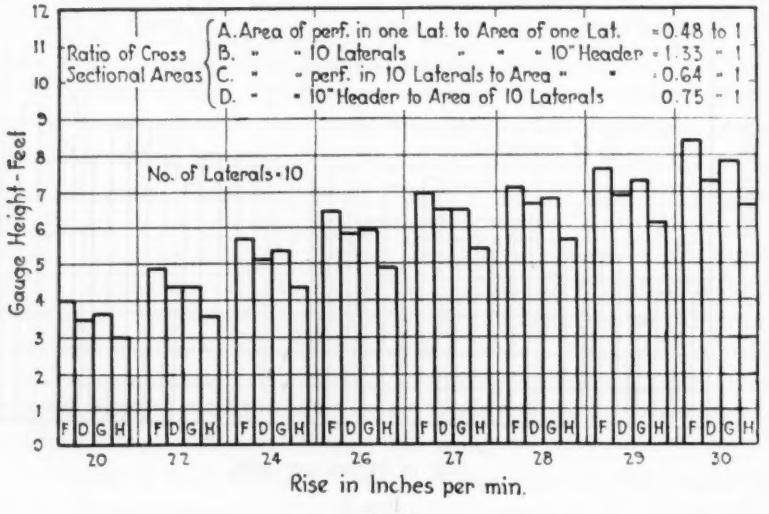
Ratio of Cross Sectional Areas
A. Area of perf. in one Lat. to Area of one Lat. = 0.48 to 1
B. " " 10 Laterals " " " 10" Header = 1.33 = 1
C. " " perf. in 10 Laterals to Area " " = 0.64 = 1
D. " " 10" Header to Area of 10 Laterals = 0.75 = 1
No. of Laterals = 10
Gauge Height - Feet
F D G H
20 22 24 26 27 28 29 30
Rise in Inches per min.

FIG. 5

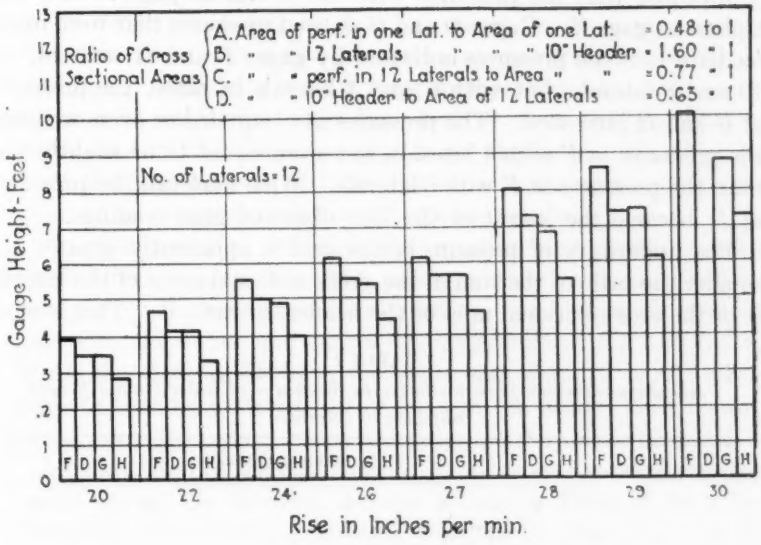
Ratio of Cross Sectional Areas
A. Area of perf. in one Lat. to Area of one Lat. = 0.48 to 1
B. " " 12 Laterals " " " 10" Header = 1.60 " 1
C. " " perf. in 12 Laterals to Area " " = 0.77 " 1
D. " " 10" Header to Area of 12 Laterals = 0.63 " 1
No. of Laterals = 12
Gauge Height - Feet
F D G H
20 22 24 26 27 28 29 30
Rise in Inches per min.

FIG. 6

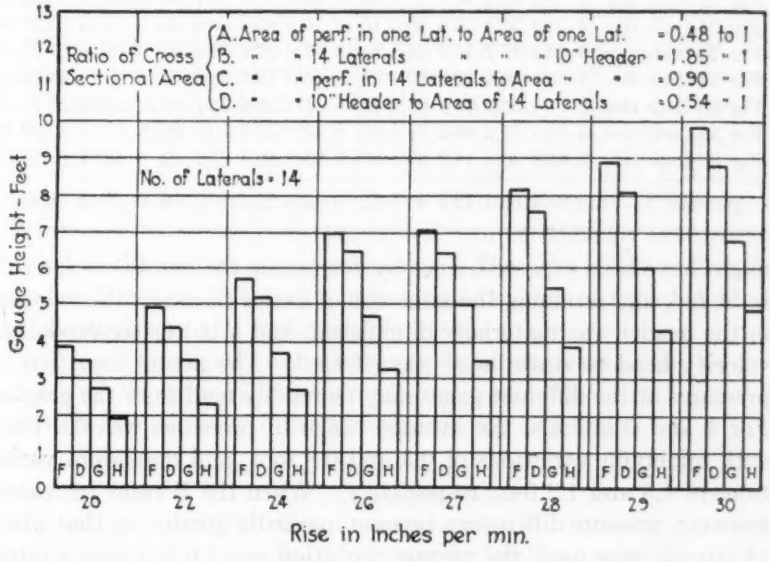
Ratio of Cross Sectional Area
A. Area of perf. in one Lat. to Area of one Lat. = 0.48 to 1
B. " " 14 Laterals " " " 10" Header = 1.85 " 1
C. " " perf. in 14 Laterals to Area " " = 0.90 " 1
D. " " 10" Header to Area of 14 Laterals = 0.54 " 1
No. of Laterals = 14
Gauge Height - Feet
F D G H
20 22 24 26 27 28 29 30
Rise in Inches per min.

FIG. 7

it appeared that the pressures were the lowest at gage *H* and the highest at gage *F*. Gages *D* and *G* showed pressures that were intermediate between pressures indicated by gages *F* and *H* with 14, 12, 10 and 8 laterals; but with 6 and 4 laterals in place, the pressures at *G* and *H* increased. The pressures at *G* equaled or even exceeded the pressures at *F* with 4 laterals, but were equal to or slightly less than the pressures at *F* with 6 laterals. With 4 laterals the pressures at *D* became the lowest of the four observed gage readings.

The uniformity of pressure in the grid is apparently greater the smaller the ratio of the sum of the cross sectional areas of the laterals is to the cross sectional area of the header, or ratio B. This is what

TABLE 2

Percentage variation from mean in the discharge of water from different numbers of laterals

	NUMBER OF LATERALS											
	4		6		8		10		12		14	
	+	−	+	−	+	−	+	−	+	−	+	−
For 20-inch rise	2.30	2.97	4.98	7.40	6.64	12.90	6.26	7.95	6.76	9.58	14.50	21.20
For 22-inch rise	4.30	4.75	4.80	7.37	5.80	10.39	5.80	8.42	7.30	10.05	15.00	21.20
For 24-inch rise	4.20	4.30	3.76	6.20	6.10	11.10	5.85	8.00	6.60	9.10	15.95	20.00
For 26-inch rise	3.32	4.37	2.13	3.35	5.64	8.75	6.27	7.74	6.95	9.15	15.27	20.80
For 27-inch rise	6.17	3.10	3.32	3.70	4.75	8.45	5.12	7.68	6.12	8.18	14.40	19.62
For 28-inch rise	3.71	4.55	2.73	3.05	4.72	8.55	4.56	6.72	7.90	10.26	15.20	20.50
For 29-inch rise	3.62	4.37	2.46	2.79	5.00	8.33	4.72	6.10	7.90	8.52	15.30	20.00
For 30-inch rise	3.45	4.30	3.14	2.89	3.87	7.95	5.60	5.75	7.72	8.44	14.80	19.50
Average.....	3.88	4.09	3.42	4.60	5.32	9.55	5.52	7.30	7.16	9.16	15.05	20.35

might have been expected, since by decreasing the number of laterals to be fed, and retaining the same size of feeder (header), the velocity in the header was materially diminished, and a better conversion of velocity head to static head was effected. The actual variation in pressures at the different gages may be readily read from the graphs. For 4 and 6 laterals, the average range in pressures was 0.9 foot, with minimum variations of 0.3 and 0.8 foot, and maximum variations of 1.3 and 1.2 feet, respectively. When the B ratio increases, however, pressure differences become markedly greater, so that when 14 laterals were used, the average variation was 3.6 feet with a minimum and maximum range of 2.0 and 5.0 feet, respectively. The variations are, as a rule, greater the higher the velocity of the wash water.

Since the discharge varies as the square root of the head, the figures in the table which follows were calculated to show the percentage variation above and below the mean as determined from the gage readings. The fluctuations in the discharge varied on an average for all rates of wash water rises from 3.42 to 15.05 per cent above the mean, to 4.09 and 20.35 per cent below the mean. The discharges from the four laterals or from the six laterals were more uniform than when a larger number of laterals were in use.

It is interesting to note that the variation in the losses of head in the header (10-inch diameter pipe) averaged 0.2 and 0.36 foot, respectively, between gages *B* and *C* where 4 and 6 laterals were used, and with minimum and maximum variations of 0.1 and 0.5 foot. While the distance between the gages was short, it would seem to indicate that no material loss of head in the header need be anticipated, provided correct ratios of header to laterals are installed.

A comparison of the experimental strainer system with the one in actual use at the Division Avenue Filtration Plant of the City of Cleveland reveals some interesting relations in connection with their basic design data. At this plant the perforated pipe system is served by a four section center manifold in each half of the filter tank. Each manifold section has a variable cross section, being larger at the center and diminishing in size toward the end. At the center of the section the manifold has a cross sectional area of 135.52 square inches.

There are 384 laterals each with an effective length of 6 feet, and serving a filter area of 1451.4 square feet. These laterals are 2.5 inches in diameter, spaced $6\frac{5}{4}$ inches apart, and with $\frac{1}{4}$-inch diameter perforations which are spaced $2\frac{1}{4}$ inches apart and staggered. There are 33 perforations per lateral and in addition 1120 perforations in the bottom of the manifolds. The area of the perforations in one lateral is 1.62 square inches, and the area of the cross section of the lateral is 4.91 square inches.

Using these figures and the ratios as defined previously, the relations of the perforations, laterals and manifolds to each other for the Division Avenue Filter Plant design are as follows:

Division Avenue Filter Plant Strainer System, Cleveland, Ohio

Ratio A is equal to 0.331
Ratio B is equal to 0.873
Ratio C is equal to 0.308
Ratio D is equal to 1.15

Note: In ratios *B*, *C* and *D* the holes in the manifold sections have been disregarded.

Comparing these ratios with those of the experimental strainer system, we find that "Ratio A" of the latter is larger or 0.48 to one. We also find that the ratio of the length of the lateral to its diameter or L/D, as expressed by Jenks of Sacramento, is 49 in the experimental strainer system (and which is in accord with his findings), as against L/D equal to 29 in the Division Avenue Filter Plant design.

It should also be noted that, if we disregard the holes in the manifold in the Division Avenue Filter Plant design, the ratios B, C and D all fall within the limits of the experimental system ratios where 4 or 6 laterals were used. The holes in the manifold itself would not make much of a change in the ratios even if they were included.

GENERAL CONCLUSIONS

While it is recognized that the experiments made do not give ideal results, nevertheless they clearly indicate the limits which should not be exceeded. It is plainly apparent that the sum of the cross sectional areas of the laterals should be at least twice the sum of the cross sectional areas of the perforations in the laterals; and that the manifolds feeding the laterals should have cross sectional areas from 1.75 to 2.00 times the sum of the cross sectional areas of the laterals which they feed in the washing process. These experiments also confirm the investigations of Jenks in Sacramento in showing that longer laterals of the proper diameter may be used and still produce a good distribution of the wash water. This condition offers an excellent opportunity to employ only one manifold for both halves of the filter tank by placing it under the center gutter, thus reducing the number of manifolds and providing for a gravel and sand bed of uniform thickness throughout. This design has already been successfully incorporated in one filter plant having two-million-gallon filter units; but it is obvious that it can also be applied to the design of units of even twice this capacity with equal success, since the lengths of the laterals in the experimental strainer system were sufficient to serve easily one-half a filter unit of four million gallons daily capacity.

SANITARY SAFEGUARDS IN WELL CONSTRUCTION[1]

By W. Scott Johnson[2] and H. A. Buehler[3]

Adequate supervision and inspection for the purpose of assuring essential sanitary safeguards, necessarily installed during well construction, have in the past been difficult to secure in Missouri. As a guide for specifications covering such construction a comprehensive report, on the sanitary protection for wells, was submitted by the Committee of the Conference of State Sanitary Engineers on the Sanitary Control in the Development of Ground Water Supplies and adopted in 1925 at the Louisville, Kentucky, meeting. However, specifications covering all possible conditions encountered would not be practical and each well requires individual expert attention during its construction period. Experience indicates that, granting the individuals in charge of drilling operations are thoroughly awake to the importance of proper sanitary well construction, there is still the factor of widely varying geological conditions encountered in Missouri, which demand expert technical supervision in order to assure safe and economical results. The method of securing this, through coöperation of the State Geologist and the State Board of Health, is the subject of this paper.

GROUND WATER CONDITIONS IN MISSOURI

Practically all the potable ground water supplies in Missouri are located in the southern half of the state in two areas known as the Atlantic Coastal Plain and the Ozark Plateaus. The Atlantic Coastal Plain, comprising a small area in the extreme southeast corner of the state, formerly contained considerable swamp land which has been drained. The water supply is secured from a shallow underground flow which is protected by a layer of fine sand frequently supplemented by a sealing layer of shale. This water is of excellent quality and the subsurface conditions are such as to assure proper well construction with little or no difficulty.

[1] Presented before the Chicago Convention, June 9, 1927.

[2] Chief Sanitary Engineer, State Board of Health, Jefferson, Mo.

[3] State Geologist, Jefferson, Mo.

Throughout the Ozark Plateau region, the geological conditions are very different and the water supplies in this section are obtained principally from deep wells drilled in rock. This region is one of the oldest uplifts in this country. The sandstone which supplies the most satisfactory water supply is overlaid by several hundred feet of limestone badly fissured and shattered. Contaminated surface water gains access through sink holes and outcroppings to great depth due to these conditions. Indicative of this condition some of the largest springs and caves in the United States are located in this territory. There are on record numerous accounts of substances of a surface origin, such as sawdust and lubricating oil, traveling for miles through underground channels before appearing again at the surface.

A striking example of the fissured and open condition of the limestone strata in this territory is illustrated by the experience of a city of 3000 population with its water supply. Extremely careless methods of sewage disposal had resulted in the discharge of the overflow of septic tanks into abandoned wells and sink holes for many years. The two city wells were 850 and 1300 feet deep respectively, and each was cased 600 feet, a third well was drilled 2690 feet deep and cased to a depth of 1050 feet. Bacteriological analyses of water from these wells showed intermittent contamination. A careful study was made regarding the construction and protection of these wells for the purpose of determining the cause of this contamination. However, no sanitary defects were discovered, and it was concluded that fissures and channels in the limestone were carrying the heavy pollution from the shallow strata under the city to the source of the deep well water supplies. The only solution of the difficulty was purification and this was immediately provided for by the city.

NECESSITY OF SUPERVISION DURING CONSTRUCTION

Many well drillers, engineers and the public at large have assumed and have firmly established the erroneous but popular idea that water from underground sources is always pure. This view has become particularly dangerous from the standpoint of public health due to the increasing pollution of underground strata and the growing demand of small towns for municipal water supplies developed as cheaply as possible. A well supply is the most feasible solution, and the necessary tendency toward economy almost invariably results in as short a casing as possible. In order to secure a sufficient quantity of water, often guaranteed by the driller, one natural tendency

is for developing the largest yield possible and against properly sealing the casing to shut out the contaminated water from shallow strata.

An investigation of the ground water supplies in Missouri by the State Board of Health indicated that many wells had not been properly constructed and were consequently subject to contamination. This condition was of particular danger in the Ozark Plateau region where insufficient casing or failure to seal the same properly at the bottom constitutes a ready avenue for the entrance of pollution. As a matter of fact there are records of more epidemics occurring from ground water supplies in the State in the past than from surface water supplies. The fact that a well improperly constructed from the sanitary standpoint has given no cause for alarm over a considerable period of time is no assurance of its continued innocence. Pollution of a poorly constructed well from subsurface sources may be indefinitely postponed or of intermittent character so that ordinary routine laboratory analyses by the State Board of Health will not always be of value in indicating the danger. One particular case of a town of 2000 population, which has been using a well supply for a number of years, is a striking illustration of this condition.

A survey of the well supplying this town, made by an engineer with the State Board of Health, revealed that the casing was only 16 to 20 feet deep or just to the first rock layer. Further investigation revealed that this first rock cap outcropped only a short distance from the well and that in addition the sourrounding region contained many sink holes. Bacteriological analyses of the water showed the presence of B. coli. On the basis of this information the State Board of Health recommended that the water be disinfected with chlorine at once by means of a temporary machine until the well could be properly reconstructed or arrangements made for permanent purification. The danger from surface contamination of this well was concurred in by a subsequent report of the State Geologist. However, the emergency chlorinator was not properly constructed and the dose control was inadequately supervised. Several weeks later a severe epidemic of dysentery broke out among the citizens. Over 125 cases occurred and the city physician reported the epidemic as typically water-borne. Shortly following the epidemic during a period of heavy pumping the well water began to show muddy and this condition became worse and continued as long as the well was used. The pollution of this well was undoubtedly caused by water of recent surface origin gaining entrance below the shallow casing.

Following these difficulties the city drilled a new well properly constructed from the sanitary standpoint with a casing 550 feet deep and tightly sealed. The analyses of samples of water from this well have consistently indicated water of excellent quality and of course free from turbidity.

In seeking to secure satisfactory well construction from the sanitary standpoint, various specifications have been formulated. Of these the one proposed by the State Conference of Sanitary Engineers is probably the most thorough. However, while these specifications are entirely satisfactory in securing proper well construction with regard to many sanitary features, they are inadequate as regards others. It is possible by means of specifications to secure a casing of certain weight and material and assure satisfactory construction at the well top to eliminate surface contamination. However, these precautions are of small avail if the casing is not set sufficiently deep and tightly sealed so as to shut out the contaminated water following solution channels in the subsurface limestone.

Specifications covering these particular features of well construction have not alone been found entirely satisfactory for several reasons. It is not safe or economical to specify one certain depth for casings to apply under all conditions. In Missouri the satisfactory depth of casing has varied from 100 to 600 or 700 feet, with no assurance that this may not be decreased or increased under conditions to be encountered in the future. This part of well construction is not subject to inspection after completion and it is extremely difficult, if not impossible, to gain information concerning it after the well is complete. Presupposing a desire on the part of those concerned to carry out the intent of the specifications, the adequate interpretation of it under varying geological conditions encountered requires a specialized technical knowledge of geology, not possessed by the average engineer or well driller. Consequently, it has proven impossible in many instances for the State Board of Health to have adequate assurance of satisfactory well construction through the agency of specifications alone.

METHOD OF SECURING SATISFACTORY WELL CONSTRUCTION

In order to overcome this difficulty in the sanitary construction of well water supplies a coöperative agreement was entered into between the State Board of Health and the State Geologist that has proven most successful.

Specifications have been prepared covering the sanitary features of wells drilled in rock and the installation of well pumping machinery. All engineers are required to include these in specifications for the construction of municipal water supplies secured from wells. (See appendices A and B.)

In accordance with an agreement, the State Geologist is informed concerning a proposed well water supply and the driller is required to send a written notice to that office at least one week before operation is started. This gives the State Geologist an opportunity to advise with the driller concerning the probable conditions to be encountered and also to supply a set of sacks for drillings and a drill record book. After drilling operations are begun the driller is required to secure cuttings from every screw, place same in sacks, label and send at once to the State Geologist. Also, all information concerning openings, fissures or soft or broken ground encountered is reported. From these data the State Geologist determines the depth at which it will be necessary to place the casing in order to exclude water of recent surface origin following solution channels and fissures in the rock. When the proper depth for setting the casing has been reached a field representative of the State Geologist inspects the job, supervises the sealing of the casing and checks the tightness of seal, as required by the specifications. After completion of the well all samples of cuttings secured after casing and the complete record book of log are forwarded to the State Geologist, who correlates same and furnishes the owner and the State Board of Health with a copy of the completed log of the well.

Upon completion of the entire job, including installation of the pump, etc., a final inspection is made by an engineer from the State Board of Health to check for approval the sanitary features of the well top construction, including proper drainage of pit, if same is provided for, height of well casing above pit or pump room floor, well casing material, and the effectiveness of seal between drop pipe and casing (see appendix B). At this inspection samples are collected for bacteriological analyses at the State Board of Health Laboratory and for complete chemical analysis by the State Geologist.

RESULTS

Since the inauguration of this coöperative plan for securing better sanitary safeguards in well construction, 25 municipal wells have been drilled and a large number of private and institutional wells.

The engineers in charge of work have coöperated from the first and with few exceptions expressed an appreciation for this service. Well drillers readily saw the value of the information and advice available with regard to geological features encountered in drilling wells and the opportunity which this affords of eliminating much guess work. For the past year and a half the routine procedure has operated with exceptional smoothness and satisfaction to all concerned. As more information from well logs is tabulated the State Geologist is able to give more accurate and detailed information regarding the construction necessities for proposed well supplies in the neighboring vicinity.

Still more important, the bacteriological results from these wells indicate water of excellent sanitary quality, with one exception. It is of interest to note that in this one instance it was foreseen before starting work that unusual geological conditions would in all probability cause the well supply to be unsatisfactory. In addition the accurate construction information secured with regard to these wells affords a basis for dealing with any situation which may arise in the future regarding either the quality or quantity of the water supply.

Although there are other numerous advantages which result from the operation of this plan, it is the opinion of those concerned that the improvement in the sanitary features of well construction which results in the assurance of safer water supplies more than warrants and adequately justifies the work involved.

APPENDIX A

SPECIFICATIONS COVERING SANITARY FEATURES OF WELLS DRILLED IN ROCK

1. Samples of cuttings. At least one week before starting to drill the well, the driller shall send a written request to the State Geologist, Rolla, Missouri, who will furnish a set of small sacks and a drill record book. The well driller shall save a sample of cuttings from every screw and place same in the sacks properly labeled, and forward same each day to the State Geologist.

2. Casing. The well shall be cased with a screw joint steel or wrought iron pipe installed in a watertight manner. The State Geologist will recommend the depth of casing advisable to effectively shut out contaminated surface water based upon available records. The casing shall be extended to at least this depth and deeper if necessary so as to case off all openings or soft or broken ground.

Where the water encountered is known or found to be corrosive, special provision shall be made to protect the casing from corrosion by a method approved by the State Board of Health; the contractor to receive extra compensation for same in an amount agreed upon in writing prior to undertaking the work.

The well casing shall be extended to a point from four to six inches above the elevation of the finished pump room or pump pit floor, and shall be provided with a thread at the top.

3. Seal. A satisfactory seal shall be made or installed at the bottom of the casing, by one of the following methods:

a. Setting the bottom of the casing on a shoulder in the well made by reducing the size of the drill hole, and sealing with cement grout, a lead packer or drill cuttings of a cementing character.

b. Driving casing into clay, shale or similar sealing formation.

c. Installing an expanding rubber packer.

The seal shall be tested by bailing out the drill hole and making sure that there is no leakage into same over a period of forty-eight hours. When no appreciable amount of water has been encountered up to time of sealing, at least 1000 gallons of water shall be run into the annular space on the outside of the casing to test the seal.

4. Water analysis. Where a waterbearing stratum, furnishing the required volume of water, is encountered at a satisfactory depth, samples of water shall be collected at the end of the pumping test run and submitted to the State Geologist or private chemist for complete chemical analysis, including the iron, manganese, and hardness content, to determine the suitability of the water for a general city supply.

5. Records. The driller shall note in the drill record book the location and depth of any openings or soft or broken ground encountered, together with complete information on the depth of casing, method of sealing same, and result of test of seal.

Immediately on completion of the well, and prior to completion if requested, the driller shall forward all samples of cuttings and the drill record book to the State Geologist, who will correlate same and furnish the owner with a copy of the completed log of the well.

6. Approval. These specifications shall be carried out in a manner satisfactory to the State Board of Health, before this portion of the work is accepted.

APPENDIX B

SPECIFICATIONS COVERING SANITARY FEATURES IN THE INSTALLATION OF WELL PUMPING MACHINERY

A. The use of a well pit or subground-level pump room shall be avoided wherever practicable on account of the possibility of stoppage of the drain or ejector and neglect to replace the well top seal after making repairs.

B. Where the pump is installed without a pit.

1. The pump shall be installed on a concrete base of sufficient height to permit the outside casing to extend at least 4 inches above the pump room floor, and to enable the installation of a suitable connection as noted under B–2

2. The annular opening between the outside casing and pump column shall be closed by means of a suitable watertight connection which will effectually prevent waste water, oil, insects or other contaminating material from entering the well.

C. Where the pump is installed with a pit or in a pump room below the ground level.

1. The sides and bottom of the pit or pump room, below the ground level, shall be constructed of watertight concrete. The pit shall be left uncovered to permit easy inspection by the pump operator, and shall be surrounded by concrete curb at least 6 inches high and a pipe railing.

2. The annular opening between the outside casing and pump column shall be closed by means of a watertight connection capable of withstanding for twenty-four hours, without leakage, the water pressure resulting from complete filling of the pit with water. The types of connections approved are given below in order of preference.

a. An all flanged or threaded connection.

b. A stuffing box connection.

c. Metal to grouted cement connection with suitable gasket (not rubber); to be used only when joint carries weight of pump and is rigidly supported to prevent vibration.

Any vents provided for the well shall be extended by a pipe with screw or flange connections to a point above the floor level. A return ell shall be screwed on the upper end of this pipe, and screened.

3. Drainage shall be provided for the pump pit or pump room by one of the following methods:

a. By means of a drain consisting of a sewer pipe, not less than 6 inches in diameter, with cemented joints, installed in a straight line and on an even grade of not less than 0.6 foot per 100 feet, with a concrete bulkhead at the outlet to insure an open discharge at all times; provided that under no conditions shall this drain receive sewage, or be connected to a sewer, and that the bottom of the pit so drained shall be above the high water level in any adjacent watercourse.

b. By means of a pump or ejector drawing from a sump of not less than 12 cubic feet capacity situated so as to collect all waste water. This pump or ejector shall operate automatically or be connected to some moving part of the pump head, so as to operate continuously with this pump, and shall discharge above the pump room floor level into a suitable drain at a point safely removed from the pump pit or pump room.

4. The bottom of the pit or pump room shall be sloped away from the top of the well casing toward the drain or sump with sufficient grade to insure ready flow. The well casing shall extend four to six inches above the pump pit floor and at least six inches difference in elevation shall be provided between the top of the well casing and high water level in the sump.

d. A separate pump column, suction or discharge pipe shall be installed inside the well casing in all instances, whether the well is to be pumped by suction, air lift or deep well pump.

E. These specifications shall be carried out in a manner satisfactory to the State Board of Health of Missouri, before this portion of the work is accepted.

ELECTRIFICATION OF UPPER PUMPING STATION, AUBURN, N. Y.[1]

By A. J. Adams[2]

Auburn, in the center of the Finger Lakes Region, has a population of approximately 37,000 people. It is situated on both banks of the Owasco Outlet about 2 miles northerly from the foot of Owasco Lake.

A more ideal residential city would be difficult to find and its diversified manufacturing interests aid materially in maintaining the stable business conditions which Auburn has enjoyed for so many years. The city has shown no phenomenal growth during the past few decades, the census reports showing practically constant figures. Furthermore no rapid increase in population is expected in the near future.

The city obtained its first public water supply about 1867 when the Auburn Water Works Company was inaugurated as a private corporation. In 1894, the Board of Water Commissioners was created for the purpose of supplying to the city a mode of acquiring and operating its own water supply. The property of the private company was subsequently purchased for the sum of $425,000.00.

The plant transferred at that time consisted of an upper pumping station at the lake with an intake, extending but a short distance from the station, and a line, used as a syphon, running to the lower or pressure station located at the state dam. This pipe is approximately 9000 feet in length and 24 inches in diameter. There were some 20 miles of water mains, mostly of concrete construction, of which only about 25 per cent were even as large as 4-inch. There were 303 hydrants of which only 39 were two-way.

The Board of Water Commissioners operated the Department until January 1, 1921. In the twenty-six years of their administration, this modest beginning has developed into a modern plant which will compare favorably with any water system for a town of equal size in the country.

[1] Presented before the New York Section meeting, May 5, 1927.

[2] Chief Engineer and Superintendent, Water Department, Auburn, N. Y.

Improvements under the Commissioners include the replacing of the short, 24-inch intake with a new 36-inch pipe extending 1875 feet from the upper station which is itself 1100 feet from the shore. A new suction well, 15 feet in depth below the surface of the lake, was constructed and the influent was protected by a screen chamber.

The upper station was practically reconstructed and a new Snow pump and boilers added. At the lower station, a new, ten million gallon, R. D. Wood pump and engine with a battery of three boilers were installed, which necessitated a large addition to the buildings. The 20 miles of mains have been relaid and additional lines constructed until now we have a well gridironed distribution system, 70 miles in length, of which very few are smaller than 4 inches in diameter.

A modern, slow sand, filtration plant having a net area of 1.59 acres, together with a 3 million gallon, pure water reservoir, was placed into service in 1920. The cost of this construction was approximately $350,000.00. In addition to these improvements, the city has been 100 per cent metered.

In 1920, the city government was changed from the Mayor-Aldermanic plan to the Commissioner-Manager form known as "Plan C." On January 1, 1921, the Board of Water Commissioners was abolished and the water department taken over by the city government with the city manager as administrative head of the department. No other change was made in the operating personnel of the water department.

Early in 1924, the firm of Hazen and Whipple, the consulting engineers who designed the filtration plant, were engaged to make a survey of the water department and to report their findings to the city manager.

In their report, of first importance was the recommended construction of a storage reservoir in the distribution system to hold at least a 24 hour supply. This is a prime requisite in a direct pumping system such as is employed at Auburn.

At the lower station, we have sufficient water power which would be available for the entire pumping operations for about 9 months of the year in connection with such a reservoir. However, at the present time, boilers are fired, steam pressure up and reserve equipment hot at all times for use in an emergency. Thus much coal is burned which does no actual work.

Continuing their recommendations, the consulting engineers

suggest the installation of two new, Diesel engine driven centrifugal pumps, each capable of carrying the full domestic load, for use at the lower station when water power is low and for emergencies. They suggested also a new water wheel with direct connected electric generator, together with a transmission line to the upper station to operate electrically driven, centrifugal pumps proposed for that station. As a reserve for the upper station in case of trouble with the water driven generator, an electric generator to be driven by the Diesel engines was proposed. The estimated cost of all of these improvements, to make the system safe, was a little over $400,000.00.

In working out the operating costs under the proposed scheme, it was shown that the economies affected would practically carry the fixed charges on the proposed new investment. In conclusion, they recommended that the entire program be carried out, but if this could not be accomplished, that the fulfillment of any part of the program would show its advantages.

As the electrification of the upper station, purchasing power from the local power company, had been discussed for some time, it was decided for the present to install the electrically driven units at this station obtaining the current from the power company. This was the least expensive part of the program which would show a return upon the investment.

Of the two steam driven pumps at the Lake Station, the antiquated Holly pump and engine were practically worthless while the 10 million gallon Snow pump, together with the two, 100 horse power boilers, were in fair condition. It was proposed to replace the Holly pump and engine with equivalent electrically driven equipment, holding the Snow pump and boilers intact for reserve.

After careful study of the raw water requirements at the filter plant, the following average yearly operating rates were worked out applicable for some years at our anticipated growth:

	hours
4½ million gallons per day	1,664
5 million gallons per day	2,920
5½ million gallons per day	1,566
6 million gallons per day	1,570
7 million gallons per day	1,040

This variation in pumping rates is necessary to keep the head of raw water fairly constant over the sand beds at the filter plant. The suction lift from the surface of the lake to the pump room floor

averages 7 feet including friction. The static head on the discharge line is 29 feet. Between the filter plant and the upper station is a long line of 24-inch transmission main which develops considerable friction loss under high rates of flow.

On the basis of the above mentioned pumping rates, the total dynamic heads under which the pumps would operate were determined as follows:

	feet
At 7 m.g.d. rate	60
At 6 m.g.d. rate	54
At 5½ m.g.d. rate	51
At 5 m.g.d. rate	49
At 4½ m.g.d. rate	46½

As before mentioned, it was decided to replace only the old Holly pump at this time. After careful consideration, it was determined that better operating conditions could be obtained by installing two units for the variation in our rates. Consequently, proposals were asked—for one, 7 million gallon, centrifugal pump direct connected to a slip ring, variable speed motor for operation under the 7 to 5½ million gallon rates and also one 5 million gallon pump likewise direct connected to a slip ring variable speed motor for use at the 5 million gallon rate and lower.

To avoid keeping a boiler under fire with steam pressure sufficient to start the Snow steam driven pump for use in case of serious failure of the electrical supply, we decided to install on one end of the shaft of the larger pump a gasoline engine of sufficient power to drive the pump at capacity and also capable of increasing the pump speed to obtain the required total capacity under the Underwriters requirements, when running the pump together with the steam driven unit. For priming the centrifugal pumps, Nash Hytors were chosen, one direct connected to an electric motor and the other to a gasoline engine.

Under the proposed scheme, we considered that we would have an extremely flexible combination. Either of the two electrically driven centrifugal pumps could be operated or both together as the occasion demanded. In case of failure of the electrical supply, the gasoline driven engine could be used as a prime mover and as a last resort, we could fall back upon the steam driven equipment which was to be left in place.

In answer to our advertisement for proposals, we received propo-

sitions from 12 pump manufacturers which resulted in very keen competition. In canvassing these proposals, consideration was given not only to the first cost of the equipment, but also, using the overall efficiences furnished with the bids, the probable annual operating costs under each proposal were worked out. Under this method of tabulating the bids, the proposal of the Turbine Equipment Company was accepted as the most advantageous to the city. Under their contract, De Laval centrifugal pumps with General Electric motors were furnished and a Buffalo gasoline engine provided as the standby.

All changes to the suction and discharge piping were made, concrete foundations constructed and the entire installation of the equipment carried out by the regular employees of the water department. To provide one unit in reserve at all times, the 5 million gallon pump was set up on a temporary foundation, connected to the mains and supplied with energy, ready for operation, before the old Holly pump was dismantled.

Early in August, 1926, the entire installation was completed and, in October, an acceptance test was made on the pumps in the field with the result that the guarantees were amply fulfilled. The larger pump showed an overall efficiency of 73½ per cent while the 5 million pump gave 72 per cent.

Primarily, the motive for the installation of these new pumps was the replacing of worn out machinery and the improvement in reliability at this station. As a result of these improvements, we have eliminated seventy-five points of the deficiency rating established by the National Board of Underwriters. Also, we believe that a material saving will be shown in the annual operating costs for this plant.

For the past six years under steam driven operation, the annual cost of this station has averaged $19,900, exclusive of repairs. With the electrically driven equipment in service, our operating costs are running about $1450 per month or $17,500 per year. These costs will be reduced by a further saving of $1575 per year in labor as soon as the engineers are thoroughly familiar with the new equipment.

Table 1 shows the first cost and installation charges for this improvement.

Under the present city manager plan of government for the past six years, the water department revenues have increased from $137,000 to $156,700 with an increase in operating costs of only

from $113,400 in 1920 to $114,800 in 1926. During this period there has been practically no increase in population and the water rates have not been advanced.

TABLE 1

Cost data on new pumping equipment

Switch board and installation	$2,261.99
Pumps, motors, engines, etc.	7,853.33
Cast iron pipes, specials and fittings	1,932.97
Gates and valves	1,790.20
Freight and cartage	650.57
Foundation materials, etc.	484.34
Machine work and labor	242.74
Removing old equipment, materials	100.69
Engineering expense	75.39
Printing and advertising	38.30
Pay rolls	1,504.81
Total	$16,935.33
Credits, return of materials, sale of materials, junk, etc.	638.86
Net cost of improvement	$16,296.47

As of January 1, 1927, the outstanding bonded indebtedness of the Department was $237,000. With the reserve in the sinking fund of $43,367 our net debt is $193,633. The total book value of the plant, not considering allowance for depreciation, is $1,600,000.

CONSTRUCTION AND OPERATION OF THE MEMPHIS WATER WORKS[1]

By James Sheahan[2]

The city of Memphis has a commission form of government established January 1, 1910. The present members are: Rowlett Paine, Mayor and Commissioner of Public Affairs and Health; Thos. H. Allen, Vice-Mayor and Commissioner of Fire and Police; Charles R. Shannon, Commissioner of Accounts, Finances and Revenues; Harry N. Howe, Commissioner of Streets, Bridges and Sewers, and Horace Johnson, Commissioner of Public Utilities, Buildings and Improvements. The population is estimated at 200,000. The United States Census in 1920 showed 162,351.

The leading industries are the manufacture of hardwoods and its products, cotton and its products and assembling of automobiles. It is also an important distributing center for merchandise.

There are approximately 400 miles of dedicated streets, 125 miles of which are hard surfaced, 200 miles graveled and the rest unimproved.

The water supply was purchased by the city in 1903. The operation of the water department is under the supervision of a board of three commissioners appointed by the Mayor, one every two years for six-year terms. The board appoints a general superintendent, secretary and resident engineer. The general superintendent is in responsible charge of operation. The present commissioners are F. G. Proutt, Chairman, Jno. M. Dean, Vice-Chairman and W. W. Mallory. The officers are James Sheahan, general superintendent; Sanford Morison, secretary, and Carl E. Davis, resident engineer.

The parkway pumping station is divided into a main pump room, a boiler room and a machine shop. The walls are brick; the roof is concrete supported by steel girders. The main floor is concrete covered with tile. The basement floor is also concrete.

[1] Presented before the Kentucky-Tennessee Section meeting, January 21, 1927.

[2] General Superintendent, Water Department, Memphis, Tenn.

WATER SUPPLY AND DISTRIBUTION SYSTEM

The pumping capacity of the Memphis water department is over 60,000,000 gallons per day. Normal conditions require the use of only one-half of this, keeping one-half in reserve.

Although the city has access to the Mississippi River, it secures its water supply from two strata of water bearing sand, one 450 feet below the surface, the other 1400 feet. The department has 29 wells in service, all of which are not needed at one time. They are used alternately. As much as 18,000,000 gallons have been taken in 24 hours from 13 wells. From 1.0 to 1.5 million gallons of water are pumped per day from each well that is operated.

The department has approximately 380 miles of mains inside and outside of the city. There are probably 15 miles of mains outside the city. The supply mains are of sufficient carrying capacity, there being two 30-inch and one 24-inch line from the Parkway Station to supply all parts of the city. The smaller mains are 4-inch and up to 20-inch. The department does not install smaller than 6-inch mains at the present time and are replacing all 4-inch mains, which are few in number, with larger ones. All dead ends are being eliminated as fast as possible.

The department is 100 per cent metered, having over 36,000 meters in active service. In addition to this, there are approximately 300 sprinkler connections for fire protection. There are also approximately 2500 fire plugs within the city limits.

The total pumpage for the year 1926 was 5,608,455,000 gallons, or a daily average of 15,365,630.

The department furnishes all mains, all service connections, all meters and meter connections free. Meters are set in sidewalks at the curb.

Mechanical equipment

The machinery consists of (*a*) Two Worthington horizontal cross compound fly wheel pumps, manufactured in 1923. These pumps are double acting and condensing, with steam cylinders 23 by 54 inches in diameter, 36-inch stroke, and run at 45 revolutions per minute. The water plunger is 22 inches in diameter. The water pressure is 70 pounds. The daily capacity is 15,000,000 gallons each.

(*b*) Two single stage, centrifugal water turbines, directly connected through reducing gears to 650 h.p. steam turbines. The water turbines are run at 1050 revolutions per minute, maintaining a pressure of 70 pounds, and are of 15,000,000 gallons capacity each.

(*c*) Three Worthington single stage, centrifugal water driven turbines, directly connected and driven by city pressure, pumping against a water pressure of 8 pounds, and having a capacity of 9,000,000 gallons each.

(*d*) Four Casey-Hedges water tube boilers, 3500 square feet heating surface, 350 h.p., maximum pressure of 225 pounds, averaging 210,200 degrees superheat, consuming about 33 tons of bituminous coal per day.

(*e*) Four Nordberg two stage air compressors, having a capacity of 2700 cubic feet of air per minute, and with a maximum speed of 105 revolutions per minute. There are two or three compressors constantly in use during the entire twenty-four hours, according to the load. These compressors are operated at 90 to 95 per cent of their maximum capacity. It is found that these machines can be operated at a better advantage at this rate.

The electric machinery consists of two 125 h.p. Chuse poppet valve uniflow engines driving 2 General Electric 100 k.w. generators. These units are used to light the building and to operate motors which drive the forced draft to the boilers, the coal hoist, the devices of the machine shop, the crane and all auxiliary machinery in the plant. One unit is operated at the time, the other is always in reserve.

The boiler room is large and roomy, with ample light and ventilation. Each boiler is a single unit with 21-inch brick wall and is encased in steel, making it impossible for air leaks in the wall. The boilers are equipped with forced draft, each being driven by separate motor. There is a fan blower operated by a steam turbine for emergency should the electric machinery get out of order. Each boiler is equipped with Bailey meters and CO_2 Recorders. There is a surge tank, one Cochrane open heater and 3 Worthington boiler feed pumps.

The boilers are fed by four Riley underfeed stokers, from which very good results are obtained. The stokers are driven by Sturdivant engines. The boilers are equipped with four Foster superheaters which average 150 degrees of superheat. The coal is carried to the boiler room by a chain hoist to the coal hopper, which has a capacity of 500 tons. All coal is weighed before being fired and an accurate account kept. The efficiency of the boilers is above 70 per cent.

The high pressure cylinder of the Worthington cross compound condensing pumps is equipped with poppet valves, driven by cams; low pressure with Corliss valve gears. The pumps are regulated as to speed by governor control. If the pump exceeds an 18,000,000 gallon rate, the governor automatically shuts the pump down. The pumps are operated at 85 to 90 per cent of their capacity, except in emergency load, when they are operated at full capacity. The steam consumption per horse power is approximately 10 pounds. The slippage at the water end is 2 per cent.

The two general electric steam turbines are of satisfactory efficiency. Careful checking, however, shows them to be more expensive in fuel consumption per million gallons of water pumped than the cross compound. The upkeep is very small.

The Nordberg air compressors are the only compressors of the type made. The high pressure cylinder has poppet valves. The low pressure cylinder is of the uniflow and Corliss valve type. Steam consumption is from $9\frac{3}{4}$ to 10

pounds per horse power. The volumetric air efficiency is about 93 per cent. We consider them the best manufactured.

Sources of supply

There are twenty-two 12-inch wells, 450 to 500 feet deep, and seven 8-inch wells, 1400 feet deep, of which some are located on the Park Ground around the plant, some on lots facing the Parkway and others on the water department's ground in the northeast part of the city. These wells extend over a territory nearly two miles in length. The water is lifted from the wells by air and flows to a 30-inch collecting main, which increases in size to a 42-inch. The 42-inch collecting main empties into two 36-inch mains which carry the water, by gravity, into the raw water basin of the reservoir, thence to the low pressure pumps.

There are air lines running the entire distance of the wells, four 10- and two 6-inch lines leaving the plant. They cut off at different intervals, leaving a battery of six wells to be operated at one time, or as many wells can be operated at one time as is desired. It is so arranged, if lines get out of order, that we can cut out any part and keep operating just the same. All air going into the wells is measured with Jersey meters, and all water coming from the wells with Venturi meters. These readings compare with the air and water records of the meters at the Parkway Station. The amount of air consumed per minute averages approximately 275 cubic feet to 700 gallons of water raised.

When wells are at rest, water from the upper stratum stands about 50 feet from the surface; from the 1400 feet stratum, about 15 feet. The water taken from the wells before applying air shows CO_2 gas to the extent of about 135 parts per million. The air lift, aerator and filter release all but 3 or 4 per cent of the entire gas. The iron in the water is also eliminated by these means.

Aerators

Three single stage directly connected turbines are driven by water pressure from the water mains. The daily capacity is 9,000,000 gallons each. The use of the turbine is to lift the water from the raw water basin of the reservoir to the aeration plant where it passes through the riser and is distributed equally through a quadrant. It then flows through trays, of which there are 40 to each quadrant. The trays are made of cypress strips about $\frac{1}{2}$ by 1 inch, and $\frac{1}{2}$ inch

apart, and are filled with coke. The frame work supporting the trays is concrete and steel. The idea of the trays is to break the water into small particles to allow all gases not eliminated by the air lift to escape. The aerated water passes through a small baffled chamber underneath the floor and thence to the filter. The purpose of this chamber is partly for mixing, if needed.

Filters

Filters are of the rapid sand type with eight reinforced concrete units of 825 square feet each. All units have perforated pipe under drains. Beds are composed of bottom layers of graded gravel 18 inches in depth and top layers of sand 30 inches deep. The only need of the filter is to remove the iron and gas from the water, it being unnecessary ordinarily to use any chemicals for purification. However, a chlorine installation is held in readiness should occasion require its use.

The filtered water flows from the filter plant through a duct which is connected with the suction chambers of the primary pumps, and also connected with and maintaining a level flow with the filtered water basin of the reservoir. Should the consumption be greater than the supply from the filter plant, the reservoir supplies the deficiency. Should the supply from the filter plant be greater than the consumption, the excess flows to the reservoir. The capacity of the reservoir is 10,000,000 gallons.

WELL WATER RECESSIONS IN ILLINOIS[1]

By G. C. Habermeyer[2]

An artesian well 711 feet deep was drilled in Chicago[3] in 1864 at the corner of Chicago and Western Avenues and the pressure at the ground surface was about 80 feet. The owners of the well proposed to drill two 15-inch wells and secure water (20,000,000 gallons a day) at sufficient pressure to supply the city without pumping. Their expectations have never been realized, for, although many wells have been drilled into the same water-bearing stratum and other strata of which Professor Leighton has spoken, and the quantity of water pumped is increasing, the water level has receded until many wells have been abandoned on account o fthe high cost of pumping from great depths.

An important factor in the lowering of the water level is the increase in the quantity of water pumped and this will be discussed briefly for: (1) wells into porous material overlaid only by porous material, (2) wells piercing several water-bearing strata with water from all but the bottom stratum cased out, and (3) wells piercing several water-bearing strata with no water cased out.

Figure 1 shows a well into porous material into which water from the ground surface percolates freely. The line through *O* shows the the water level when not pumping and the line marked *H.G.L.*, hydraulic grade line, marks the water surface when pumping. With little lowering of water level the yield may vary nearly in proportion to the lowering. As the bottom of the stratum is approached the relative area of flow decreases and the velocity increases more rapidly, giving higher friction loss and greater lowering in proportion to the yield, until the bottom of the stratum is reached when increased lowering gives no increase in yield.

Pumping for a long time at a higher rate than the rate at which water enters the stratum will cause a continued lowering of the water

[1] Presented before the Chicago Convention, June 9, 1927.

[2] Engineer, Illinois State Water Survey, Urbana, Ill.

[3] History of the Chicago Artesian Well. Religio Philosophical Publishing Association. 1866.

level until the level is near the bottom of the stratum and then the yield will decrease.

Figure 2 shows an artesian well piercing two water-bearing strata with water from the upper stratum cased off. The line through *O* shows the height to which water rises in the well when not pumping and the line marked *H.G.L.*, hydraulic grade line, shows the elevation to which water from the lower stratum would rise while pumping.

Figure 3 shows three types of wells, *A* and *B* as in figures 1 and 2, and *C*, a well into the same water-bearing strata penetrated by *B*,

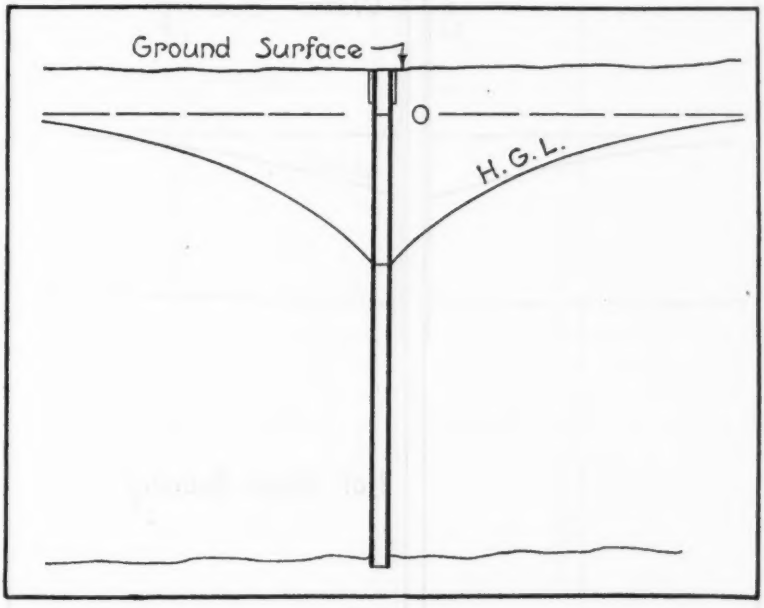

FIG. 1

but with no water cased out. A great majority of our deep wells secure water from more than one stratum as shown at *C*. With water standing at different levels in wells *A* and *B*, all water pumped from well *C* will be from the stratum from which water rises the higher, until the water level is drawn down below the depth at which it stands in either *A* or *B*. Then, with increased pumping, water will be drawn from both strata and the rate of lowering with increased pumping may be a little less or very much less than before.

Drilling and pumping from additional wells in an area may change

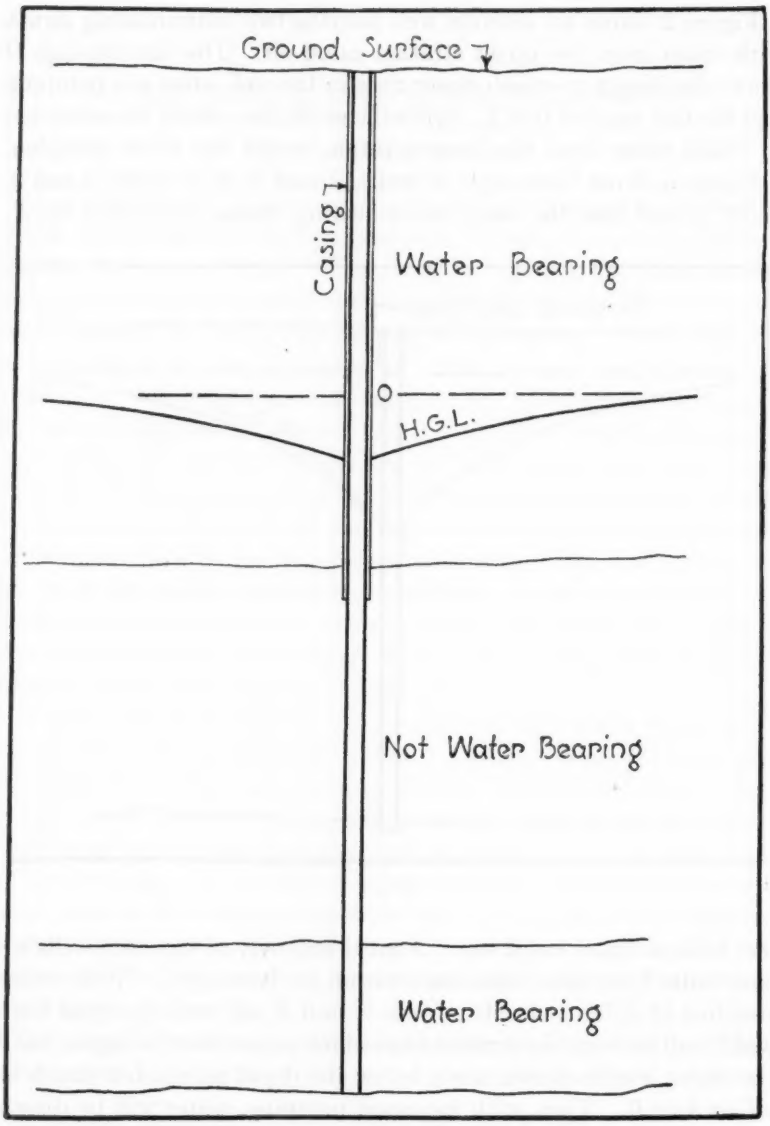
Ground Surface
Casing
Water Bearing
H.G.L.
Not Water Bearing
Water Bearing

FIG. 2

conditions on account of the quantity of water pumped greatly exceeding the capacity of strata which had supplied all or nearly all demands.

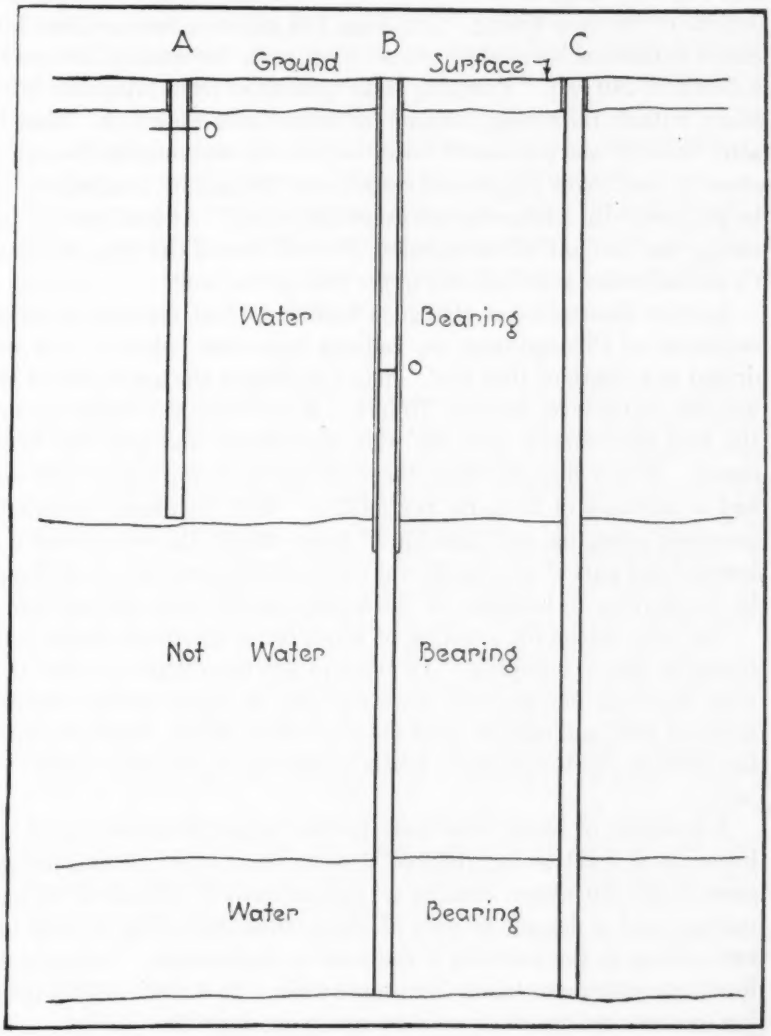

FIG. 3

The United States Geological Survey has developed a current meter to determine velocities at all depths in flowing wells, and thus determine the flow into or out of a well for each stratum.

A well in use for many years by the Village of Western Springs, a few miles west of Chicago, illustrates all three types of wells. The well was 2046 feet deep, was cased 1765 feet, to Mt. Simon sandstone, and was very large at the top, giving a well into Niagaran limestone outside of the deep casing. Pumping 110 gallons a minute from Mt. Simon sandstone lowered the water level inside the casing, 150 feet to a depth of 240 feet. Pumping large quantities from Niagaran limestone, outside the casing, lowered the water level a few feet. Shortly after the well was completed water both inside and outside the casing stood 15 feet below the ground surface and 600 gallons a minute could be pumped with a lowering not exceeding 6 feet. At least part of the casing was then out of commission, the well was of the type shown at *C*, and all water was from the upper part of the well.

Another illustration of change in conditions is at Lansing, a village southeast of Chicago near the Indiana State line, where a well was drilled to a depth of 1632 feet. When drilling in the lower part of the well the water level dropped 70 feet. Water from the upper part of the well then flowed into the well, downward, and out into lower strata. Water pumped from the well was from the upper part and had a hardness of 20 parts per million. With increasing demands, increased pumping, and draining of upper strata, the water level was lowered and part of the supply was secured from lower strata as shown by an increase in hardness of the supply to 650 parts per million.

The only reason for lowering of water levels discussed above is increase in rate of pumping. An attempt has been made to show that with increased pumping the lowering may be slight between certain limits of yield and may be great between other limits, depending upon the relative yields and water levels in various strata penetrated by a well.

A lowering of water level may be due in part to other causes. A lowering of level giving reduced pressure in a stratum may release gases from the water, causing a readjustment in dissolved mineral matters and a deposit of part of them, thus increasing friction loss and adding to the lowering if the yield is maintained. Deposits are found on equipment taken from some wells. It is claimed that blasting has restored yields of wells by removing deposits.

Growths on walls of wells and in the strata are given as a possible cause of decrease in yield or lowering of level to obtain the same yield.

Mechanical clogging of strata with fine sand or other material may add greatly to friction losses and thus to lowering of water level.

Compression of water-bearing strata is given by Oscar E. Meinzer and Herbert A. Hard as an explanation of lowering of water level.[4] A reduction of pressure in a stratum is equivalent, in some respects to increased pressure on the stratum. Increased pressure gives compression which reduces the voids in the stratum. Yields from wells in the past, greater than present yields with higher water levels than present levels, can then be explained, as part of the yields were of water in storage in the vicinity of the wells. This explains a lag in adjustment of water levels with changes in yields. Compression will also have a direct effect on the increase in friction loss.

Conditions in various states in regard to water level recessions due to the causes mentioned or possibly other causes, will be given by the persons whose names appear on the program. I shall give a few facts in regard to conditions in Illinois.

CONDITIONS IN ILLINOIS

The water levels in deep wells in northern Illinois have receded considerably. A large part of the lowering is due to increased pumping and an effort has been made to determine the quantity of water pumped from wells penetrating the lower water-bearing strata, including St. Peter sandstone and all lower strata. This is given for several areas and the Chicago suburban area is here considered as area in Illinois from Lake Michigan along the Wisconsin State line to Fox River; southward including Elgin, Aurora, and Morris; southeastward to include Kankakee; eastward to the Indiana State line; and north to the lake. Reasonably accurate data have been secured in this area by H. L. White of the State Water Survey Division. Data of municipal supplies outside of this area have been secured from Bulletin 21, issued by that survey, and from city and village officials. Few data are readily available in regard to industrial use of water from deep wells outside of Chicago and the suburban area, and this has been assumed at between 2,500,000 and 7,500,000. Quantities pumped per day for areas given are as follows:

	million gallons per day
Stock yards area in Chicago	10
City of Chicago	15
Cook County	30
Chicago and suburban area	50
State of Illinois	70 to 75

[4] United States Geological Survey, Water Supply Paper 520.

The largest yields are from wells into Cambrian sandstones. They supply about 95 per cent of the quantity given for Chicago and suburban area and probably 85 per cent of the quantity given for the state. Water levels given will be for wells into Cambrian sandstone.

The lowering of water level in the stock yards area is shown in figure 4. The curve, to 1915, is copied from State Geological Survey Bulletin 34. Water stood at the ground surface in 1889 and at a depth of 212 feet in 1914. The bulletin gives the quantity of water pumped per day in the latter year as 13,450,200 gallons in the stock yards and 30,100,000 gallons in Chicago. Since that date nearly all wells formerly in use at breweries have been abandoned and many other wells have been abandoned on account of increasing costs of

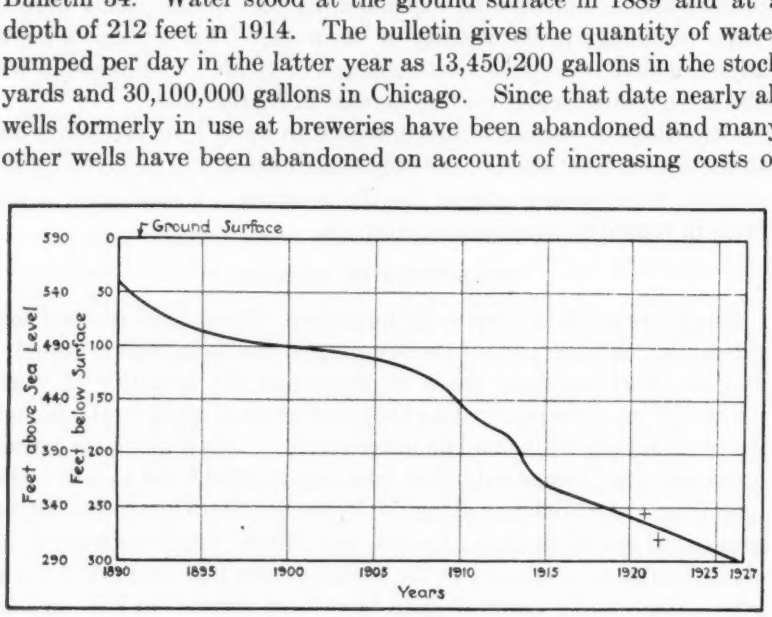

FIG. 4

pumping from greater depths and superior quality of the city supply. Some wells have been drilled and nearly all of the wells now in use are pumped almost continuously at a high rate, many yielding 1,000 gallons a minute or more. The quantity pumped in the suburbs has increased very rapidly.

Recent information in regard to levels at the stock yards is principally from Armour and Company and was secured with the assistance of G. B. Mulloy and others. The water level in one well, last month, when the pump had been idle one day, was 300 feet below the ground surface, about 290 feet above sea level. When pumping 800 gallons a minute the depth to water was close to 340 feet, as a hole was found in the suction line at that depth and other equipment in good repair in other wells discharged more water.

Within 6 miles of the stock yards, on land not more than 10 feet higher, excepting to the south and southeast where practically no deep wells are in use and we have no record, depths to water when not pumping are reported as about 300 feet, some a little more, some less. At a plant of the Corn Products Refining Company, 8 miles west and south, where land is at about the same elevation, the depth to water when pumping 2,300,000 gallons a day from a group of wells, is 340 feet.

In wells at Maywood, about 10 miles west and 5 miles north of the stock yards, in an area where the quantity of water pumped has increased rapidly, the water level was approximately 555 feet above sea level in 1907 and 375 feet above in 1927.

North and northwest of the stock yards more than 7 miles little water is pumped from deep wells. At Park Ridge, 15 miles northwest, the water level was 565 feet above sea level in 1914 and 67 feet lower, or about 500 feet above sea level in 1927.

At North Chicago, 35 miles north, wells now flow several feet above the lake level, about 590 feet above sea level.

At Rockford the water level was about 740 feet above sea level in 1885, 720 feet above in 1891, 707 feet in 1910, 697 feet in 1919, and approximately 690 feet in new wells in 1923.

At Galena, close to the northwest corner of the State, it was reported in 1886, when a well 1547 feet was drilled, that the flow was 500 gallons a minute and that water would rise to 84 feet above the ground surface, 694 feet above sea level. In 1896 water would rise to 32 feet above the ground surface. After repairing the well the pressure at the top, in 1925, with small flow through a waste valve, was 32 feet. Another well of practically the same depth, 8 inches in diameter, located 130 feet from the older well, had been completed in 1921. When pumps were not operating there was a small flow from the two wells through a blow-off valve and a pressure gauge on the pump suction registered 36 feet. When pumping from the two wells at a rate of 750 gallons a minute the pressure at the top of the wells was 8 feet, indicating that, with zero pressure at the top, a flow close to 500 gallons per minute per well could be obtained, for a short time at least.

Analysis of the causes of the recession of the water level in this state would be difficult. The majority of the wells in use pierce several water-bearing strata and have little casing, so the quantity of water pumped from each stratum is not known. Many wells more

than 1800 feet deep in the western suburbs of Chicago yield several hundred gallons a minute, of which a large part is from the upper 300 or 400 feet of the wells, as shown by low temperatures. A well at Western Springs has been given as an example.

With increased demands, wells have been drilled deeper or replaced by deeper wells into lower water-bearing strata, so that conditions are not directly comparable with conditions of ten years ago. However, practically all water pumped in the stock yards district is, and for many years has been, from wells about 1600 feet deep.

A large part of all water pumped is from Cambrian sandstone, as has been noted, but there are several water-bearing sandstones in the Cambrian system and many of the wells at one location are drilled into lower strata than are wells at other places nearby. For example, at Aurora, 35 miles west of Chicago, wells are drilled more than 1000 feet into the Cambrian system, while wells in use at the stock yards are drilled about 200 feet into this system.

About the only conclusion that can be drawn at this time seems to be that the water level lowering depends in large part directly upon the quantity of water pumped and that part of the change is due to some of the other factors which have been given as possible causes. The great lowering near Chicago may be due in part to compression of strata.

In the vicinity of Chicago, where the greatest quantity of well water is used, much of the water is now from wells drilled as deep as can be drilled without securing salty water, and the water level has receded until some wells have been abandoned, so it may be that conditions will be more uniform during the next few years and additional information can be obtained.

WATER WORKS VALUATION[1]

By Lewis E. Gettle[2]

Active regulation of water and other utilities has been in operation in Wisconsin for about twenty years. During this time certain classifications of accounts have been adopted and applied in accordance with the statutes. Yearly reports have been submitted by the utilities. From the twenty year study of plant experience, records and reports, court decisions and opinions, transfers, voluntary and otherwise, considerable knowledge has been acquired useful in regulation and in the determination of values for the issuance of securities, rate making, or of the compensation to be paid for the taking of a utility. The intent has been to maintain a healthy condition in keeping with the public welfare and the demand for service with justice both to the consumers and the owners of the utilities.

Many of the original water distribution systems and pumping stations in Wisconsin were built by contractors in the period 1880–1890 when prices of materials and the labor rate of pay were much lower than in the present so-called post-war period of readjustment. Extensions, improvements and additions were made in piece-meal fashion with the growth, development and requirements of the various cities. Following the entrance of the United States in the war construction was deferred in many cities by high prices or shortage of labor or material. Since the war construction has been resumed and appears now to be near the normal.

You are probably familiar with the fluctuations in the price of cast iron pipe. Since 1923 the price of Class B water pipe has had a downward trend, being quoted in Iron Age of May 3, 1923 at $60.20 and of September 29, 1927 at $34.20 to $37.20 per net ton f.o.b. Chicago. Common labor throughout the state has also had a downward trend except in centers of unusual activity such as Madison, Kenosha and Racine. In some cities the labor rate of pay has decreased since 1923 approximately 10 per cent. The rate of pay of skilled labor, organized,

[1] Presented before the Wisconsin Section meeting, October 14, 1927.

[2] Chairman, Wisconsin Railroad Commission, Madison, Wis.

and often at variance with common labor in leading or lagging, appears to be well maintained and advancing in some places. From the facts and the prospects it cannot be said with much assurance that we have arrived at a level of prices for water works materials and labor.

In the earliest years of regulation the commission used a reproduction cost valuation applying prices for materials and labor representing a five year average. This five year period included 1906 and 1907, years in which cast iron pipe was quoted and sold at prices higher than the other years of the period. About 1913 a ten year average for pricing replaced the five year average. With the greatly increased price of cast iron pipe and labor after January 1, 1916, and the general reduction in amount of new work done, the 10 year average reproduction cost valuation was continued for the portion of the physical property in place prior to January 1, 1916, adding thereto the actual cost of additions made subsequent to January 1, 1926. For these additions the records of the companies were available. In the calculations and estimates throughout these years the commission's engineering staff was governed somewhat by the manner in which the property had been built up, with reproduction assumed to be done in a manner corresponding to the facts found in a study of the historical development of the property. Local conditions were carefully considered and results could be predicted with some uniformity. The method and application of price bases throughout these years produced workable results with reasonable effort and generally fully covering the investment of the then existing utility.

Recent United States Supreme Court decisions and our own supreme court decision in the Waukesha Gas & Electric Company case have had an important bearing upon the rules of valuation which the railroad commission is required to apply. The decision in the Indianapolis Water Company case, while so worded as not to exclude in later cases other elements of value, seemed to indicate clearly the adoption of the policy of giving material and considerable weight to that measure of value represented by what it would cost to reproduce the existing property at present prices. If it were possible to know the Indianapolis property and to have intimate knowledge of the manner in which the estimates of reproduction cost were made and the result applied, we might the more closely understand the opinion and thought of the court and the weight which should be given to such measure of value when valuing other properties. The formulation of

a method is helpful though a statement set forth in a decision may require some time for clarification and common understanding.

CHAPTER ON VALUATION IN THE MANUAL

In chapter XXII of the manual "Water Works Practice" published in 1925 by the American Water Works Association, some of the factors and difficulties involved in valuations of water utilities are set forth clearly. In the short time at my disposal I can, of course, discuss or mention only a few items of uncertainty and those very briefly. Engineers working honestly and impartially upon the same premises may arrive at results close to each other. Ignoring the facts or methods derived from a study of the historical development of a property may allow a variation in assumptions of reproduction and corresponding differences in results. Inspection by engineers of a distribution system at a season of unusually high water, with the ground water table near the surface might result in a temporarily high reproduction cost estimate. For example, a person visiting Oconto or Marinette at certain times of the year might conclude that pipe laying in sections of these cities is extremely difficult. Likewise, very low or very high lake levels may affect the ground water table and present for several years abnormal excavating conditions. Cities by ordinances may require that pipes be laid prior to paving, yet a measure of value might be so construed as to require an estimate of cost of an equivalent dual system of piping in the terraces at the edge of a so-called permanent paving or of the cutting through of a hard pavement. New and cheaper forms of pipe are being made and sold. Which of the present forms of pipe shall be used, if the original form or type of piping is obsolete and at present unreasonably expensive to reproduce? In a reproduction cost estimate of laying pipes how much, if any, consideration should be given to the congestion in the down town district? Improvement and development of satisfactory types of machinery for the laying of mains have come within recent years. Only in a few cities have utilities had enough construction in a season to justify the ownership of a trenching machine. On large jobs today trenching machines are commonly used if soil conditions are suitable. The size of the job would determine the use of various other labor saving and cost reducing devices. Various assumptions may be made as to the order, speed and time in which a system might be built, making more or less effective the use of crews and machinery. There are many assumptions which may be made and regarded as

reasonable and in accordance with usual fact. Opportunities for differences appear numerous. Adherence or consideration given to methods employed in the development of the property may eliminate many differences. However, each case seems to present new features, new problems for solution.

The allowances usually made for construction overhead costs will be affected by the assumptions made as to time and methods of construction. The usual practice of the railroad commission of Wisconsin has been in the past to add 15 per cent to the groups, land, transmission and distribution, buildings and miscellaneous structures, plant equipment and general equipment for the construction overhead allowances. This percentage has been composed of the following items:

	per cent
Organization and legal expense	1.5
Engineering and general supervision	5
Interest during construction	5
Taxes	1.5
Omissions	2

Our engineers have drawn a marked distinction between the words "omissions" and "contingencies." When construction is originally proposed many of the later developments in such construction are unknown and cannot be foreseen. There will often be changes in plans, foundations may reveal great difficulties and increased expense and engineers generally will make a fairly liberal allowance for such contingencies. It is only after completion of the construction that it is usually possible to discover and set forth these unforeseen costs. It is quite evident that, after a plant has been completed, all of those things that were contingencies at the inception of the project have become realities and the history of the construction of the plant discloses or at least should disclose, if such history is accessible, the actual experience of the company, and these things designated as contingencies have become ascertained facts and can be so treated in the valuation. The term "omissions" is intended to cover certain used and useful items of the property which have been overlooked and omitted. Experience in the checking of inventories and the repeated listings of items indicates that an allowance of 2 per cent is quite fair for general use. In some instances the percentage has been increased or modified in accordance with the haste or manner of taking or checking the inventory.

In using an estimate of present cost of construction of a plant, less depreciation, as a fair measure of the value of the physical elements of the property the depreciation becomes an important matter for consideration. If we might have before us in advance all facts relating to the condition of the various items of inventory taken periodically throughout the life of the plant we could plot a composite curve which might be called the "experience curve" or life curve of the physical property. With obsolescence included the composite curve for certain water plants would be quite irregular and the irregularities due to obsolescence ordinarily would be expected some time after the original building of the plant. In ordinary soils in Wisconsin cast iron pipe has been found to deteriorate slowly and the corrosion, tuberculation or deposit inside may be more or less rapid depending upon the quality of the water.

In the past our engineers have used a 4 per cent sinking fund curve as a guide in lieu of the experience curve, making such modification as seemed necessary for obsolescence, from inspection, or from other knowledge of the property. A water plant may differ from other utilities in its prospect of a longer life. However, in some instances, probably rare in water utilities, the straight line basis at a particular time may in fact represent and be used to determine depreciation.

The commission must determine the value of the utility as a going concern. In cases before the commission various bases of estimating an amount to be added to a valuation of physical property have been presented. Among these are a study of the historical deficits during the development period, an estimate of the deficits which would accrue if the property in business were to be reproduced as a whole, an attempt to relate the going concern value to the amount of revenue obtained in a fixed period, and in addition various arbitrary estimates such as 10 or 15 per cent of the physical property. It seems to me that all of these bases are subject to criticism and have very serious shortcomings. Any one of them can be applied to any property in such a way as to show a going value over and above that of the physical property, even though as a matter of common sense such value cannot possibly exist. Any one of them can be applied to a utility which is thoroughly unprofitable and which has no commercial possibilities in such a way as to show a considerable going concern value over and above the physical property.

If the utility is placed in a field of unhampered return or of no real need, with no prospects of earning a profit under any schedule of

rates which could be established commercially it is not worth the cost of its physical property. Cost is not value and the property cannot and does not produce an income. If the venture has been a mistaken one and has no prospects the value simply does not exist. The going value is not an item to be superimposed upon the physical value. The going concern value is the value of the entire property as a going concern and is the only true value of such property.

THE WATER YIELD FROM SMALL WATER SHEDS IN IOWA[1]

By Floyd A. Nagler[2]

With the ever increasing pollution of our middle western streams by industrial and city sewage, it is becoming more difficult for towns situated in the river valleys to secure safe and usable water. It is only a matter of time until many Iowa municipalities will be forced to seek their water supply from the flow of small streams whose water sheds can be protected from all dangerous pollution, which is now the prevailing practice in New England.

Even though the yield of Iowa streams is less than those in the East, the runoff from exceedingly small water sheds would prove adequate for the municipal supply of most of our Iowa towns. In some parts of Iowa this flow could be conducted by gravity to the municipality concerned, but, in many parts of the state, pumping would be required. With adequate storage, the average watershed may be expected to yield close to 300,000 gallons per day per square mile. In years of minimum flow, the stream may yield only one-third of this amount.

But it is not a safe procedure to base a final estimate of the yield from a small stream upon the average behavior of its neighbors. More than all other types, small streams are deceptive.

Unfortunately, very few records have been maintained from which the yield of small midwestern streams may be accurately determined. It is impossible to estimate their behavior from that of similar water sheds located either east or west of Iowa, even though both receive the same amount of precipitation.

Stream flow observations have been maintained during portions of the past twenty-five years upon many of the larger streams of Iowa. A study of these records reveals a big difference in the average water yield per square mile of the larger streams within the state. If such differences exist in the water yield of the larger

[1] Presented before the Iowa Section meeting, September 29, 1927.

[2] Professor of Hydraulic Engineering, University of Iowa, Iowa City, Iowa.

streams, it is almost certain that even larger differences will be observed in the water yield from small catchment areas located in different parts of the state, with different vegetation cover and soil conditions. The possibility of underground leakage from small water sheds may be a large contributing factor in producing a relatively small runoff from a stream located in a region where a much larger yield is to be expected.

Beginning with April, 1922, the Mississippi River Power Company at Keokuk, Iowa, has maintained a gaging station upon a water shed of only 113 square miles drained by Sugar Creek, near Keokuk. The yield of this stream has been unusually small, indicating the possibility of subterranean flow into other stream channels. A comparison of the yield of this stream with that of another typical Iowa stream is as follows:

PERIOD	SUGAR CREEK NEAR KEOKUK	IOWA RIVER ABOVE IOWA CITY
	inches	*inches*
1922—April to December (inclusive)	2.11	3.15
1923—January to December (inclusive)	0.79	3.79
1924—March to September (inclusive)	4.42	7.45
Total	7.32	14.39

It is probable that Sugar Creek received a rainfall equal to or more than the average rainfall upon the Iowa River basin, and it is surprising to note that its runoff during this period is only one-half that obtained from the Iowa River.

There is possibility of so great a difference between the yield from small streams that no water supply project contemplating such a source should be undertaken without making some measurements over a short period of time to determine the relative yield of the stream in question as compared with that to be expected from the average in that section of the state.

Realizing the scarcity of the existing data upon the yield from small water sheds in the middle west, the State University of Iowa has maintained continuous observations upon the yield from the water shed of Ralston Creek draining only three square miles of land devoted to agricultural purposes near Iowa City. The writer knows of no other continuous measurements which have been made upon

TABLE 1

Yield of water from Ralston Creek compared with run off of Iowa River at Iowa City

YEAR	MONTH	RALSTON CREEK AT IOWA CITY, 3 SQUARE MILES		IOWA RIVER AT IOWA CITY 3140 SQUARE MILES RUN OFF
		Precipitation	Run off	
		inches	*inches*	*inches*
1924	January			0.06
	February			0.30
	March			1.19
	April			0.82
	May			0.36
	June			1.37
	July			1.83
	August			1.43
	September	2.40	0.15	0.45
	October	1.57	0.09	0.30
	November	0.85	0.04	0.21
	December	1.61	0.18	0.21
Total		6.43	0.46	8.53
1925	January	0.28	0.05	0.16
	February	1.23	0.68	0.19
	March	0.95	0.47	0.31
	April	2.88	0.19	0.21
	May	0.79	0.04	0.12
	June	4.75	0.19	0.23
	July	3.23	0.01	0.15
	August	3.15	0.06	0.09
	September	5.52	0.13	0.07
	October	3.70	0.14	0.53
	November	0.83	0.12	0.22
	December	1.43	0.29	0.18
Total		28.74	2.36	2.45
1926	January	0.82	0.78	0.24
	February	1.65	0.72	0.52
	March	0.82	0.25	0.53
	April	1.79	0.67	0.36
	May	1.82	0.12	0.17
	June	5.67	0.49	0.26
	July	3.50	0.07	0.14
	August	4.64	0.16	0.23
	September	9.70	1.87	1.86
	October	1.07	0.55	0.94
	November	3.16	0.93	0.54
	December	0.90	0.42	0.40
Total		35.54	7.03	6.19

TABLE 1—*Continued*

YEAR	MONTH	RALSTON CREEK AT IOWA CITY, 3 SQUARE MILES		IOWA RIVER AT IOWA CITY 3140 SQUARE MILES RUN OFF
		Precipitation	Run off	
		inches	*inches*	*inches*
1927	January	0.24	0.15	0.28
	February	1.32	0.86	0.64
	March	3.37	1.28	0.60
	April	4.55	1.60	1.04
	May	6.54	2.22	1.48
	June	5.59	3.50	0.78
	July	1.70	0.14	0.24
	August	1.69	0.04	0.21
Total		25.00	9.79	5.27

the yield of such a small Iowa stream. Some larger streams have been under observation for some time by the engineers of the United States Geological Survey. Those draining an area less than 500 square miles are as follows:

STREAM	STATION	DRAINAGE AREA	PERIOD OF RECORD
		square miles	
Sugar Creek	Keokuk	113	April, 1922, to date
Squaw Creek	Ames	210	May, 1919, to 1924
Maquoketa River	Manchester	226	June, 1903, to July, 1903
Skunk River	Ames	320	July, 1920, to date
West Nodaway River	Villisca	350	May, 1918, to 1925

All of these streams are *rivers* compared with Ralston Creek upon which studies are being made by the staff of the Hydraulic Laboratory at the University. Yet, with complete storage, Ralston Creek drains an area large enough to furnish an average of 1,000,000 gallons per day in an average year.

The runoff from Ralston Creek is being accurately measured by means of a triangular control weir and an automatic water stage recorder. In addition to the runoff record, the precipitation upon the water shed is being measured by seven rain gages distributed over the basin. One of these rain gages is a recording rain gage, so that

records are being obtained of rainfall intensity as well as total amount. Observations of the level of the ground water are made every ten days in eight wells distributed over the water shed. These records have been maintained since September, 1924, and the monthly results showing the runoff and precipitation are given in table 1.

A comparison of the yield of this small water shed with that of the Iowa River, the yield from which is quite typical of the average from Iowa streams, indicates that the *total* yield may be quite similar. However, during wet periods the yield from the small water shed is considerably in excess of that which may be realized from the larger stream and during dry seasons the small water shed has a lower flow per square mile than that existing in the larger river.

The Ralston Creek observations are not only furnishing reliable data with respect to the water yield from a typical small midwestern drainage area, but valuable information is being obtained as to the intensity and distribution of intensity of midwestern storms, the magnitude and time of concentration of flood runoff, the reliability of readings of adjacent rain gages, the influence of vegetation upon stream yield, the rate of infiltration of rain water into soils, and the influence of ground water upon stream flow.

COUNCIL BLUFFS' RECENT WATER WORKS IMPROVEMENTS[1]

By Arthur L. Mullergren[2]

The city of Council Bluffs, Iowa, has just completed a new high service pumping station and improvements to its low service station as a part of its program of development for the future.

The Board of Trustees found that their existing pumping facilities were becoming inadequate for the growing demands and that the operating costs were steadily increasing. They determined that before any improvements were undertaken it would be advisable to have a thorough survey made to determine the most feasible scheme of development and most economical types of equipment for the present as well as future conditions.

The author was retained as consulting engineer to make a thorough survey and study of their water works system, make recommendations as to the proper method of procedure and determine the kind of improvements that should be made to fit in with the future requirements. The recently completed high service station and the improvements to the low service station are, in part, the result of the survey and recommendations.

DESCRIPTION OF PRESENT SUPPLY

The water supply is obtained from the Missouri River by means of an electrically operated low service pumping station located on the banks of this river. The low service equipment consists of one 12 and one 11 million gallon per day 32-foot head single stage centrifugal pump, each direct connected to a 100 h.p. induction motor, and one 8 million gallon per day centrifugal pump direct connected to a Sterling gasoline engine. The gasoline unit is used as reserve equipment or for emergency service. These pumps discharge into seven large settling basins located immediately adjacent to the pumping station, and known as the Dodge Park site. After

[1] Presented before the Iowa Section meeting, September 30, 1927.

[2] Consulting Engineer, Kansas City, Mo.

passing through these basins the water flows through a 24 inch line to three large settling basins located at the Broadway high service station site. The distance between the two sets of basins is approximately 3500 feet. To provide a sufficient flow of water between the two sets of basins, an 8 million gallon electrically operated booster pump is used. Water is supplied to the distribution system by the Broadway high service station.

No filters are used, but the city has been able to furnish a very satisfactory quality of water owing to the large amount of sedimentation basin capacity. The water is treated with lime and alum at the Dodge Park basins. Liquid chlorine is supplied for sterilization at the suction of the high service pumps.

Owing to the topography of the city, booster pumps are required to serve two districts which have elevations considerably higher than the main part of the city. Water is pumped through the distribution system into a large concrete storage reservoir which floats on the system and its elevation gives approximately 65 pounds pressure to the main part of the city. One of the district booster stations is located at this concrete storage reservoir and takes the water directly from the reservoir and pumps into the district supplied by means of duplicate 300 gallons per minute electrically operated centrifugal pumps. The other booster station takes its water directly from the main distribution system and pumps into its high service district. Each district has an elevated steel storage tank of sufficient elevation to give domestic pressure to its district. These two districts are some distance apart, but the elevated tanks have their overflows set at the same elevation so that it is possible to tie the two together and supply both from either pumping station. This is another one of the recommended improvements.

Before the new motor driven high service station was installed, the high service pumping equipment consisted of two 8 million gallon triple expansion pumping engines and three 250 h.p. Scotch Marine type boilers designed for 150 pounds pressure. However, it was found that it was impossible to secure more than $6\frac{1}{2}$ million gallons per day from one of the pumping engines owing to the condition of the equipment, and the plant was practically dependent on one unit during the peak season, as the peak requirements were in excess of this amount. The Board of Trustees were confronted with the problem of either installing an additional pumping engine for the same steam conditions or else install a new pumping plant in order to use the

latest types of pumping equipment. The maintenance and repair items on the pumping units and boilers were increasing yearly and the overall efficiency of the plant was low due to the poor steam conditions, type of boiler settings and general arrangement of piping and installation. In view of the fact that the entire water supply of the city was dependent upon this station, it was impossible to dismantle same or completely rehabilitate it until the new pumping equipment was installed.

REVIEW OF NECESSARY IMPROVEMENTS

A very thorough study was made of the pumping requirements and conditions to determine the types of equipment that would be most economical and suitable for Council Bluffs. The triple expansion pumping unit was eliminated from consideration due to its higher annual costs over the steam turbine type. Either type of equipment would necessitate the installation of additional boiler facilities in order to secure the advantages of better steam conditions and also to secure a gain in efficiency of boiler operation over the existing boilers.

Complete analyses were made of the cost of installing and operating three types of pumping equipment, as follows: steam turbine driven pumping units, Diesel oil engine pumping units, and electric motor driven pumping units.

It would have been possible to install in the old pump room one steam turbine driven pumping unit of 8 million gallons daily capacity, and, at a later date, one of the old triple expansion pumping units could be removed and a second turbine driven unit installed in its place. It was found that the boiler room would have to be remodeled and one of the existing boilers removed in order to provide space and height for suitable capacity higher pressure boilers. However, this arrangement would have necessitated operating the old triple expansion units at one steam pressure with its boilers and the new turbine units at another steam pressure with its boilers. This would have caused some complication in the piping arrangement until such time as the second turbine driven unit was installed with its boiler so as to provide duplicate equipment throughout. The building in which the old equipment was housed would have had to be rebuilt, as it was not fireproof and not of the design desired for modern pumping equipment.

For a Diesel engine installation a complete new building would have been necessary owing to the height and additional space required. It

was found that a complete new motor driven pumping station could be constructed at a smaller cost than endeavoring to install the steam equipment in the old building in the manner outlined above. In view of the fact that the low service station and low service booster pump were already electrically equipped and operated and electric current purchased from the local power company for these stations, and the rates offered by the power company were on a sliding scale, a great advantage could be secured from the lower rates offered by the increased use with additional motor driven pumping equipment. Owing to the fact that the low service station and the low service booster pump were located at different sites and separated from the high service station and the pumping head was very small, purchased electric power for these two stations showed a decided advantage by reason of the fact that extra attendants would be unnecessary.

In working out a comparative set-up of operating charges for the different types of plants considered, it was necessary to take into consideration both low service stations. The best set-up for a steam turbine pumping plant would be the installation of high service steam turbine pumping units in duplicate of 8 million gallon daily capacity each, with alternating current generators installed on an extended shaft on each unit of sufficient capacity to operate the low service pumps and the low service booster pump. These pumps could be operated simultaneously with the high service pumps, as the high service storage reservoirs and the low service sedimentation basins were of such capacity that very flexible operation could be secured. The annual operating charges, including fixed charges of 11 per cent, were found to be $52,800 for an installation of one turbine unit and its necessary boiler equipment in the present building and remodeling same. For a complete new turbine plant in a new building, duplicate units throughout, the annual operating charges were found to be $63,600.

The Diesel engine pumping equipment installed in a complete new building with duplicate Diesel oil engine generating units of sufficient capacity to operate the high service pumps and all low service stations and the installation of duplicate motor driven 8 million gallon per day high service pumps, carried an annual charge of $64,000. The fixed charges for this unit were determined to be 12 per cent of the investment and considered depreciation at 6 per cent in addition to maintenance and repairs at 2 per cent.

For purchasing all of their electric power requirements the following rates were offered by the power company:

Primary or demand charge:

$1.25 per month connected horse power first 200 h.p.
1.05 per month connected horse power next 200 h.p.
0.80 per month connected horse power next 200 h.p.
0.65 per month connected horse power next 200 h.p.
0.50 per month connected horse power all in excess

Plus energy charge:

1½ cents per kilowatt hour for the first 10,000 kilowatt hours
1 cent per kilowatt hour for the next 15,000 kilowatt hours
¾ cent per kilowatt hour for all in excess

The above subject to a coal clause.

The high service installation would require 500 h.p. motors which would be of the synchronous type. Based on their previous average pumping records, it was found that the new high service station, the low service station and the booster station would use approximately 2,250,000 k.w.hrs. per year, with a connected motor load of 650 h.p. With this annual pumpage the annual rate throughout the year was determined to be 1.19 cents per k.w. hour. The annual charges for this installation with a complete new motor driven high service pumping station with duplicate 8 million gallons per day units and a Diesel oil engine generating unit for standby service of sufficient capacity to operate the high service, low service and booster stations would be $61,620, including all fixed charges. This annual charge would have been around $53,000 in the event only one motor driven unit was installed in the old building and the present steam plant was used as a standby, but for the reason stated hereinbefore, it was deemed inadvisable to consider this arrangement.

Coal costs were computed at $5.00 per ton delivered at the boiler plant for the steam installation, fuel oil at 6 cents per gallon delivered for the oil engine installation and electric current at the rates hereinbefore set out for the purchasing of power.

CHOICE OF ELECTRIC DRIVE

By comparison of the above annual charges of the three types of plants for a complete new pumping station in each case, it can be seen that the electric driven pumping station, with purchased current, was most economical and provided as reliable a service as the other two

types of plants. The reliability of service was assured by requiring the power company to install duplicate transmission lines to the high service station. The Diesel standby generating unit will afford further reliability as in event both power lines are down or trouble is encountered at the power station, the Diesel generating unit can be placed in operation within ten minutes and all three pumping stations immediately placed in operation. Duplicate underground cables will connect the high service and low service stations so as to afford reliability for the low service stations. Further reliability is secured at the low service station by the installation of a Sterling gas engine centrifugal pumping unit, making this low service station absolutely self contained.

With the present water storage capacity for both the high service and low service stations, it is possible to operate all pumping units at their full rated capacities and efficiencies and the hours of operation can be regulated accordingly.

The sizes of the units selected are such that only one unit will be required at any time to take care of the immediate requirements of the city. This condition should prevail for several years to come. It is to be noted in the layout of the high service plant that a duplicate of the initial installation can be made by an extension to the building without destroying any of the investment already made. Furthermore, in the event it becomes necessary for the power company to increase its present rates and the city finds that it can produce its power more economically, a duplicate Diesel oil engine can be installed by extending the present building and all power required for pumping can be generated at this station. The annual costs will not exceed the present annual costs. Duplicate Diesel oil engines would provide the reliability required and further reliability could be secured by using the power company for standby service only.

The operating and maintenance costs, without considering the investment or fixed charges, of the original steam high service station and the two motor driven low service stations, was around $60,000 for the past year. The maintenance charges were steadily mounting and, in the course of a year or two, the total operating costs of the old equipment would probably exceed $65,000 annually. In addition the equipment was not adequate for the city's requirements and did not provide sufficient reserve capacity. The new installation, in addition to affording absolutely reliable and adequate service, will have no greater annual costs, including the interest on the investment

made and all other fixed charges, than the direct operating costs of the old installation.

FUTURE IMPROVEMENTS

It is also proposed to install at a later date a concrete intake in the river provided with traveling screens. There will also be installed at some future date a new low service station at the Dodge Park site, so arranged that the pumps are set below the normal river level and operated with a positive suction head.

Other improvements recommended and which will be made by the city as rapidly as funds permit consist of reinforcing the distribution system so as to reduce the operating pressure at the station and afford better pressure at different points.

All of the above outlined improvements have been made from the funds derived from operations and no bond issue was necessary.

DEVELOPMENTS IN CAST IRON PIPE[1]

By H. Y. Carson[2]

The most striking development in the cast iron pipe industry has been the manufacture and introduction of centrifugally cast pipe. This material is of closer grain, greater strength and lighter weight than the standard adopted by the American Water Works Association. The cast iron pipe business is subject to very keen competition and this is accentuated by the heavy fluctuations in the production of cast iron pipe because of the alternation of bad and good times. As the cost of labor and materials entering into the price of cast iron pipe are ever on the increase, the manufacturer must install new or additional labor saving devices as well as ways and means of using to better advantage the available raw materials.

Making pipe by the centrifugal method gives promise of some material reductions in the cost of pipe, but sufficient time probably has not elapsed to determine this point.

The evolution of casting pipe first into 2- or 3-foot lengths and on up to 6, 9, 12 and 16 feet would, had we the space, make a story involving interesting details concerning the foundry business. The idea of casting pipe into 20-foot or even longer lengths might well have continued to command the attention of engineers had not the new art of bronze-welding standard lengths into 24- and 32-foot and longer laying lengths been developed.

It is natural that water distribution engineers should watch these developments with keen interest. It is significant of real progress also that the pipe manufacturer is studying with just as keen interest the field problems of those who use pipe. Coöperation is the "open sesame" to the successful future.

ELIMINATING JOINTS

Of course, the reason water works and distribution engineers have been concerning themselves about longer length pipe is to prevent

[1] Presented before the Chicago Convention, June 10, 1927.

[2] Consulting Research Engineer, National Cast Iron Pipe Company, Birmingham, Ala.

losses. The volume of water unaccounted for has in the past few years been made to dwindle from astounding figures like 50 to 25, 15 or 10 per cent. The figures are still too high.

In the built up metropolitan districts, "unaccounted" losses may not be the chief concern, but rather the damage from leaking water to property adjacent to mains. The question of how long to make the sections of pipe between field-made joints involves several considerations, such as the ability of the pipe itself to yield under external loads, the character of the joints with reference to their practicability for expansion, contraction, traffic vibration and ability to grow tighter instead of looser with age. Some of these considerations have been logically answered, but others are yet to be solved. Cast iron of high strength and having ability to yield without breaking is being studied. We can look forward to much progress in the metallurgy of cast iron.

BRONZE-WELDING

The making of long sections of bell and spigot pipe by welding together ordinary standard lengths is now an established practice, but since the technical phases of this work have been printed elsewhere[3] repetition is unnecessary.

In the repairing of breaks or cracks in cast iron, there has been at least one good method developed and the writer believes it is worth transmitting to distribution engineers. The method alluded to involves regular oxy-acetylene procedure and has come to be known as the "back stepping" method of bronze-welding.

To carry out the work of bronze-welding a cracked or broken cast iron pipe, the operator must bear in mind that two forms of breaks may call for different treatment. One form of break which no doubt is the most common is a cracked bell or a cracked spigot. Such a crack may extend longitudinally 6 to 24 inches or more. Another form of break may be in the barrel of the pipe, either running parallel to the axis of the pipe or following an irregular line partly around the circumference of the pipe.

Except in one particular, the rules for bronze-welding a crack in cast iron are identically the same[3] as to (1) preparation of the welded surfaces, (2) thickness and width of bronze, with dimensions based on thickness of the iron, as shown in table 1, (3) speed of welding, and

[3] Acetylene Journal, March, 1926, "Bronze-Welding Cast Iron Pipe," also, Gas Age-Record, May 7, 1927, p. 659.

other features of regular bronze-welding. In the procedure for bronze-welding a crack in the main body of a cast iron pipe, the operator begins his work at one of the terminals or ending places of the crack and lays the bronze on 1 inch of the cracked surface and from the proceeding 2 inches beyond the end of the crack, thereby overlapping the sound or uncracked portion of the pipe, so as to amply "cover up" the invisible portion which might otherwise extend itself out of bounds. The welder must be cautioned against heating and

TABLE 1

Practical bronze-welding data

NOMINAL DIAMETER OF PIPE	THICKNESS CLASS "A" PIPE	IDEAL WIDTH	IDEAL THICKNESS	IDEAL SPEED OR TIME OF WELDING*
inches	*inches*	*inches*	*inches*	*minutes*
2	0.25	0.40	0.61	4.0
3	0.39	0.60	0.082	6.5
4	0.42	0.65	0.091	8.0
6	0.44	0.67	0.094	11.0
8	0.46	0.71	0.098	15.0
10	0.50	0.75	0.105	18.0
12	0.54	0.82	0.114	21.0
14	0.57	0.86	0.121	24.0
16	0.60	0.91	0.127	28.5
18	0.64	0.97	0.135	31.0
20	0.67	1.03	0.142	34.0
24	0.76	1.15	0.161	41.0
30	0.88	1.35	0.186	50.0
36	0.99	1.55	0.211	60.0
42	1.10	1.67	0.232	75.0
48	1.26	1.92	0.270	85.0

* This amounts to linear inches of welding per minute.

thereby expanding the main section of the crack, but he can do this after first closing off the end of the crack with bronze. The next step is to back away from the first section of bronze a distance of 3 inches and lay additional Tobin bronze on the crack up to and joining the first lot of bronze. The third (and each other following successive step) is simply to repeat this so-called "back-stepping," until the entire crack is covered with the proper amount of bronze, as indicated in table 1. A 100 per cent weld is thereby produced, which means the attainment of strength equal to the original strength

of metal before the crack or break occurred in the pipe. When a crack at the spigot or bell end of a pipe is to be bronze-welded, the operation is even simpler, since it becomes only necessary to start welding 2 inches beyond the terminal end of the crack in the barrel of the pipe and proceeding to the open end of the crack at either the face of the bell or the spigot, as the case may be.

There are cases where it may be desired to make what is called a "Shear-Vee" weld.[4] This is done with the Tobin bronze coming even with the outer surface or periphery of the pipe. The operator should

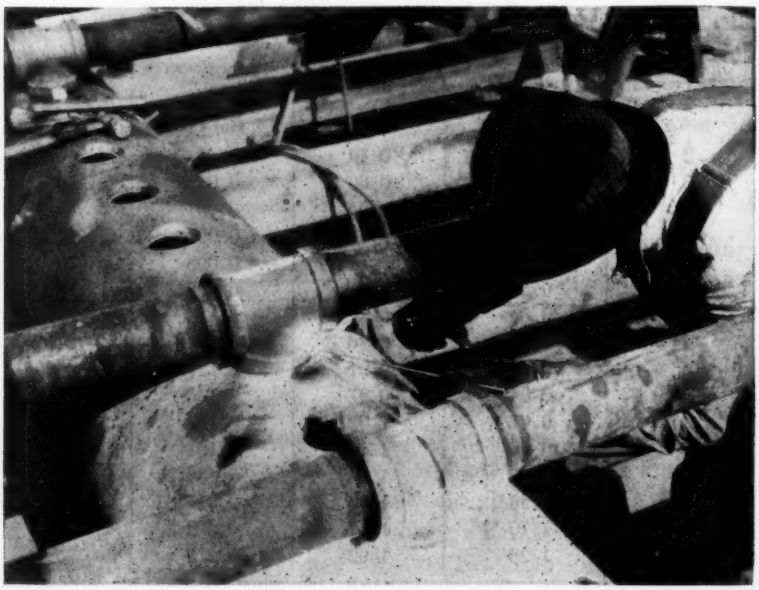

FIG. 1. LARGE DIAMETER, CEMENT-LINED, CAST-IRON PIPE TAPPED FOR THE ADDITION OF TEES

prepare such a job very carefully by cutting or grooving out with sharp chisels or grinding a small channel in the cast iron. The crack, of course, should be exactly in the center of this grooved channel and the dimensions of the cut-out portion may be determined by following the rules laid down in table 1. The operator should use a small V-shaped cut. If, for instance, the thickness of the

[4] "An Improved Joint Design for Bronze-Welded Cast Iron Pipe," by T. W. Greene and F. G. Outcault, Gas Age-Record, November 12, 1927, p. 741.

cast iron is 1 inch, the depth of the channel will be 0.21 inch and the width 1.55 inches. After the proper channel is cut for the

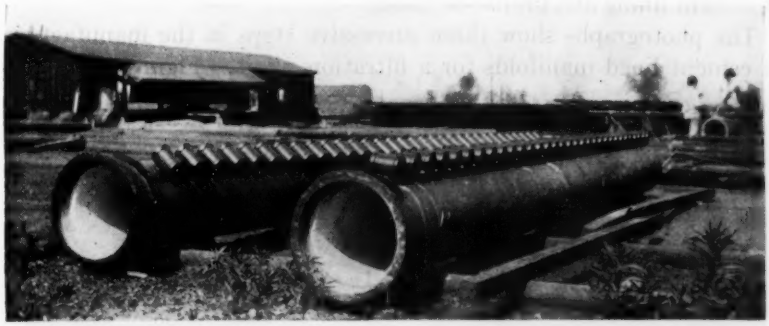

FIG. 2. TWO LARGE PIECES OF PIPE WELDED TOGETHER WITH WELDED TEES

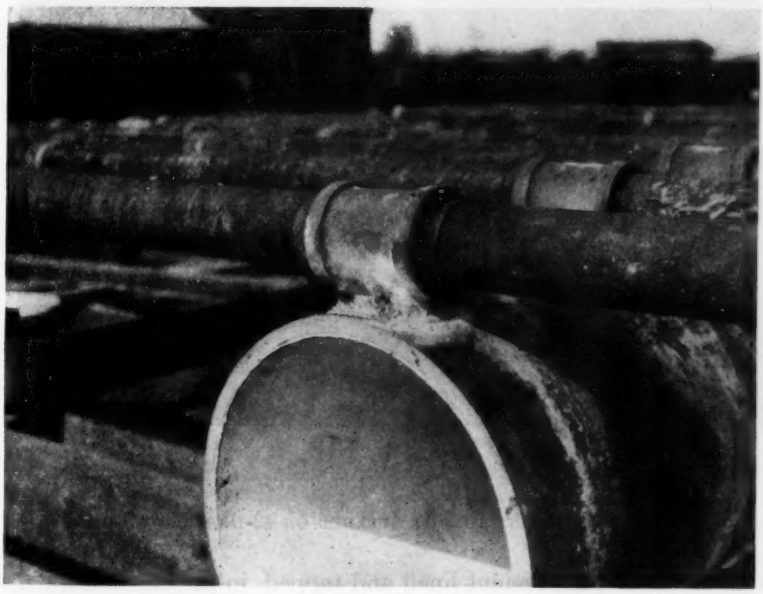

FIG. 3. ASSEMBLED MANIFOLD

reception of the bronze, the procedure of carrying the work to a conclusion is identically the same as has already been described.

Figures 1, 2 and 3 illustrate an interesting combination of two important developments in the cast iron pipe industry, a combination of cement lining and bronze-welding.

The photographs show three successive steps in the manufacture of cement lined manifolds for a filtration plant. Figure 1 shows a

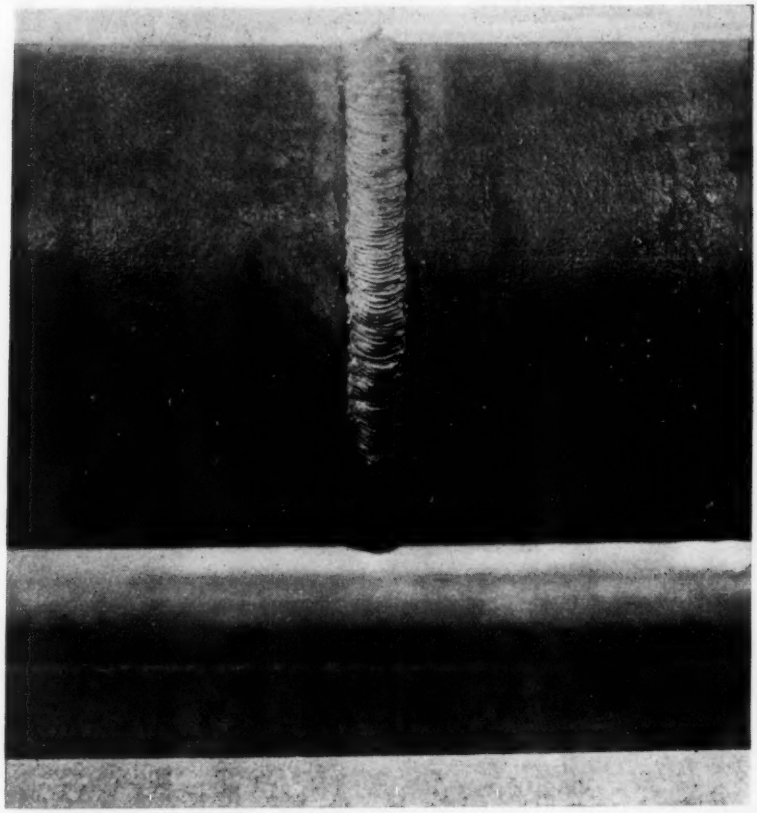

FIG. 4. A TYPICAL JOINT BRONZE WELDED ON 12-INCH CAST IRON PIPE

large diameter pipe cement lined and tapped, in preparation for the bronze-welding. Figure 2 shows two pieces of large diameter pipe welded together and the small tees bronze-welded over the holes tapped in the big pipe. The manifold completely assembled ready for installation is shown in figure 3.

The art of bronze-welding cast iron has many useful applications

in the use of pipe. It not only simplifies and reduces the cost of complicated fittings, such as the manifold illustrated, but it is being more used for repair work in general.

CEMENT LINED CAST IRON PIPE

For special services, as in the conveying of waters the chemical contents of which tend to produce tuberculation of the pipe, or where some unusual conditions of corrosion or internal friction exist, pipe foundries are equipped to furnish cast iron pipe lined centrifugally with cement mortar approximately $\frac{3}{32}$ to $\frac{3}{16}$ inch in thickness.

Tests show the cement lining to have not only the advantage of preventing tuberculation, but the flow of water through cement lined cast iron pipe is considerably greater than that through new tar dipped cast iron pipe. Depending upon the size of pipe, the velocity of water and corrosiveness or other chemical characteristics, it can be safely stated that the cement lining for pipe generally brings about an increase from 10 to 50 per cent of flow capacity with the same unit drop in pressure. In most instances, cement lined mains give assurance of being far more dependable than tar dipped pipe and for these reasons the writer believes that cement lined cast iron pipe will become standard even where the water has no highly tuberculating effect.

Apparently, the money spent on investigations of underground distribution systems as well as many other lines of endeavor is yielding some acceptable solutions to important distribution problems, increasing the durability and service value of cast iron pipe, and, above all, preventing large economic losses which otherwise might accrue to posterity who must use the thousands of miles of arteries designed to transport life supporting materials, such as water and gas.

THE TREATMENT OF WATER FOR LOCOMOTIVES[1]

By Wm. Barr[2] and Robert W. Savidge[3]

The treatment of water for locomotives consists of clarification to remove suspended matter and softening to remove the scale-forming salts. For the purposes of this discussion, treatment may be restricted to softening only. The clarification of stream water is an important problem in railway water supply, but the problems involved in sedimentation and filtration are a separate topic and will not be considered here, except as they are a part of the softening process.

On railways, methods for water treatment may be classified as partial and complete. Partial treatment is usually accomplished by the use of boiler compounds or soda ash. Of boiler compounds there are many. A new one appears almost every week. Most of them have some virtue and are usually applied in the tender of the locomotive and there react with the water when they have slowly dissolved.

BOILER COMPOUNDS

A typical boiler compound contains some alkali, usually some kind of tannin extract, and frequently silicate of soda which is also strongly caustic. The alkalies neutralize the half bound carbon dioxide and partially or wholly precipitate the bicarbonates of calcium and magnesium. Soda ash, usually present, precipitates part of the sulfates of calcium and magnesium, and some of the other ingredients may precipitate some of the scale-forming material as a sludge, so that it will not form a hard scale. The tannin extract is presumed to absorb some of the free oxygen, but the amount is usually not sufficient to have any very pronounced effect.

Some boiler compounds contain a great variety of substances which have no very direct relation to the actual softening process.

[1]Presented before the Boiler Feed Water Sessions, Chicago Convention, June 8, 1927.

[2]Consulting Chemist, Union Pacific System, Omaha, Neb.

[3]Chemist, Union Pacific System, Omaha, Neb.

Through some fancied idea of the manufacturer, or in order to produce a compound which will differ in appearance from the others, and on which a selling talk can be made with a somewhat obscure background of facts, these substances, which have no value whatever, are often added. Some compounds, having a certain value, are somewhat misused in boiler compounds, as, for example, sodium silicate which often appears in diluted and colored form and occasionally in full strength, and the buyer is told that the material contains no free alkali. It is a well known chemical fact that sodium silicate has a very strong caustic alkalinity and any such argument is false.

If used in boilers with full knowledge of the material, a certain benefit may be derived, although it is hardly to be recommended as an extremely efficient boiler compound. One of these sodium silicate compounds, with many claims attached to it, was thoroughly tested by the U. S. Railroad Administration a few years ago, and its use was condemned, not because it was utterly worthless, but because it did not fulfill the claims made for it.

In using boiler compounds it should be understood that it is only a partial treatment and that results are not to be expected that will be comparable to the use of a water with practically all of the incrustants removed.

A number of railroads make boiler compound for their own use and thus effect a considerable saving. This, however, should not be done except by someone who has made a study of such materials and who will carefully follow the application so as to secure the most satisfactory results.

USE OF SODA ASH

Another method of partial treatment which has been in use in recent years is by the addition of soda ash or some compound containing soda ash, in the wayside water tank. A certain amount of the hardness may be precipitated here, although in cold waters there is not much precipitate formed until the water enters the boiler. It is readily seen that in such cases all of the precipitate forms in the boiler and an excessive use of the blow-off will be required to handle such treatment. It is the judgment of the writers that is is not feasible to try to make water softeners out of locomotive boilers. While some relief can be obtained by internal treatment, such, for example, as adding a sufficient amount of soda ash to convert all of the sulfate hardness into carbonates, it cannot be expected to accomplish the

results of complete treatment, nor can the water be as successfully handled when the engineer is required to effect the sludge removal from the engine rather than from an outside tank. The use of anti-foaming compound is sometimes practiced with such treatment in order to reduce the foaming introduced by an excessive amount of sludge. Considering the excessive use of the blow-off, with its waste of fuel, and the use of an additional compound to reduce foaming, together with the fact that scale formation has not been completely eliminated, it must be concluded that this method is simply a palliative measure and should be used only with a full understanding of this fact.

The complete treatment of water may be obtained by the use of water softeners, either by the lime-soda, zeolite or barium methods. The use of barium treatment has never been very extensive. This is due to the high cost of barium salts combined with the fact that barium is decidedly toxic. There is always a chance that, unless treatment has been complete and clarification perfect, this may be a source of trouble. Barium treatment is only advantageous when there is a large amount of incrusting sulfates which barium carbonate will remove without leaving an equivalent amount of sodium sulfate in the water.

ZEOLITE TREATMENT

Zeolite treatment has been largely confined to laundries and the textile industries. It consists of passing the water through a bed of sodium zeolite, which exchanges its sodium for the calcium and magnesium content of the water. As a softening process, it is very effective and can be made to produce water of practically no hardness. In order to have effective zeolite treatment the water must not be turbid or contain excessive amounts of iron compounds. It is therefore necessary to filter such water before passing through the softener. Zeolite treatment was tried a number of years ago on one of the railroads, but was abandoned. It is now in use to a limited extent on one railroad, but has not been in operation for a long enough period of time to judge results.

There are certain theoretical considerations which must be taken into account in the application of this process to railroad service. In general, the action of a zeolite softener is to exchange the bicarbonates of calcium and magnesium, and the sulfates of calcium and magnesium, for the corresponding sodium salts. There is, therefore,

no appreciable reduction in the total solids of the treated water. Since the majority of hard waters carry a considerable amount of bicarbonate hardness, most zeolite treated waters have a large excess of sodium bicarbonate.

The greater the amount of sodium salts in solution, the greater will be the tendency to foam, and sodium bicarbonate especially aggravates this trouble. The zeolite method has the advantage of being very convenient to operate, but in most cases the operating cost exceeds that of the lime-soda process. It is also very important in operating such a softener for boiler purposes, that the calcium and magnesium chloride brine, which is a product of regeneration of the zeolite with salt solution, be thoroughly washed out of the softener before it is again put in operation. There may be certain places in railway service where the zeolite softener can be successfully and advantageously used, but this field is extremely limited. It is the general opinion of railroad water engineers that some form of the lime-soda water softener is better adapted to general railroad use.

LIME-SODA SOFTENER

The lime-soda water softener has been used in railroad service for more than twenty-five years. However, the design and efficiency of this type of softener has been greatly improved as a result of careful study of the operation of many machines during this period of time. The writers are still operating some softeners of this type that were built in 1903, although they have been changed in no way, they are giving reasonably good results.

The theory of operation of the lime-soda softener is quite generally understood. The bicarbonates of calcium and magnesium are broken up and precipitated by lime. The sulfates of calcium and magnesium are converted into carbonates by the addition of soda ash, and the magnesium carbonate finally converted to magnesium hydrate by more lime. With sufficient agitation and reaction time, and proper filtration, clear soft water is obtained. The bicarbonates of calcium and magnesium are reduced to a minimum of about one and one-half grains per gallon and sulfates of calcium and magnesium are converted to sodium sulfate. The ideal result cannot be uniformly obtained by the use of lime and soda alone.

The chemical reactions involved in the softening operation follow the law of mass action and are very definitely accelerated by heat and retarded by cold. In the winter months it is extremely difficult to re-

duce the hardness of a refractory water as low as desired for boiler use without the addition of some reagent to drive the reaction further toward completion.

Use of sodium aluminate

The use of sodium aluminate has recently been introduced for this purpose and with marked success. Added after the other chemicals have had a chance to react, it reacts quickly with the residual calcium and magnesium salts, producing a good floc which assists in carrying down the precipitate already formed, and effects a completeness of reaction which has not been possible in cold solutions with the ordinary treatment previously applied. In order to obtain complete precipitation in any case it is necessary to add a reasonable excess of the reagents that bring about the softening process.

On the other hand, the operation of locomotives requires that too great an excess alkalinity in the water should be avoided, as this, combined with precipitation which accumulates in the boiler, may induce foaming. However, it is important that water be treated completely because incomplete treatment gives rise to after precipitation which causes trouble in pipe lines and in the boiler. From this it is seen that in railway water softening, it is necessary to study this reaction carefully and learn just how far the softening should be carried to effect the best results.

Some municipal softening plants introduce carbon dioxide into the treated water to prevent after precipitation and to improve the taste, but this has never been shown to be profitable in handling water for boiler feed purposes.

Methods of applying chemicals

A great deal of study has been given to the methods of applying the chemicals to the water, as well as the mechanical handling of the water during the entire softening process, and this has been proved to be just as important as the use of the correct amount of chemicals themselves.

The ordinary softening practice in a ground operated machine is to mix the lime and soda ash with water in a chemical mixing tank. This is then pumped, either after dilution with soft water, or as it exists in the mixing tank, to the top of the softener, where it is mixed with the incoming raw water. Proportioning devices control the relative amounts of this chemical mixture and the raw water going into

the downtake. This mixture is sometimes agitated by paddles and sometimes allowed to pass to the bottom of the downtake without agitation, the time in the downtake being such that the chemical reaction is practically completed when the water reaches the bottom of the tank.

After the water leaves the downtake, it spreads over the larger area of the outer shell of the softener, and the upward flow is thus retarded. This upward flow being much slower than the downward flow, the precipitate gradually settles to the bottom. As this precipitate accumulates in the bottom it is removed by a sludging system, usually consisting of a series of pipes covering the bottom of the softener, with small openings such that the sum of the area of these openings does not exceed the total area of the open sludge valve. This valve consists of a quick opening gate valve, in order to get quick movement of the sludge over all parts of the tank bottom.

Excelsior filter

As the treated water flows slowly upward and the scale-forming ingredients are precipitated, the water at the top of the tank becomes clear. It is the writers' policy to have an excelsior filter at the top of the softener which completes the clarification of the water in case any light particles are carried to the top.

There is a great deal of difference of opinion on the excelsior filter. Many say that it is old fashioned and inefficient. The writers began the use of such filters twenty-five years ago and have learned many things in the operation and maintenance of this method of clarifying softened waters. As a result of this experience this method of filtration has been installed in the three latest type plants that have just been completed and put in operation.

The practice here outlined in the water softening process is subject to much variation according to opinions of operators and designers. Some machines may be successfully and conveniently operated from the top so that the chemical solutions flow by gravity as they are measured into the downtake. In some cases it is advantageous to have separate chemical tanks from which the lime and soda ash may be added separately. If alum is used, a third chemical tank is a necessity as this chemical or sodium aluminate should be added after the other two chemicals have reacted.

The velocity of stirring in the downtake or other mixing chamber is an extremely important factor in successful water treating and de-

pends upon the character of the water and the chemicals used. As a rule, violent agitation is injurious to the precipitate formed as it breaks up the floc and does not give a precipitate that will settle as completely as if a longer period of more gentle stirring is used. In such a case a flocculent precipitate is developed, the reaction is completed and when the mixture goes to the settling chamber, the precipitate settles rapidly and completely.

HORIZONTAL TYPE WATER SOFTENERS

Recently several horizontal type water softeners have been designed and installed for railway service, concrete being the material of construction. In these softeners the raw water and chemicals are introduced into a baffled race, the speed of flow being calculated so as to give the proper amount of agitation and the best floc to the precipitate. The chemicals can be introduced at any point in this race that seems to be most desirable, and separately if desired. The time in this mixing chamber is approximately one hour. From this the water is discharged into a settling chamber where it is held for one hour, and in which a very large percentage of the sludge is removed. This chamber has a sludge removal device by which most of the sludge is removed daily. There is attached to this chamber a pumping device for repumping a portion of the sludge. This is added to the mixing chamber where the water is introduced and helps to develop a more desirable precipitate. From the first settling chamber the water passes to a larger chamber where it is held for several hours and from this to the filters.

Some treated waters are used without filtering. This, however, presupposes a large settling capacity and a very complete reaction, together with perfect operation. It is well to have a filter at the end of the process as a matter of safety, so that any slight disturbance in the operation will not permit turbid water to pass through into the storage tank. This is particularly advantageous during times of peak business when it may be necessary to operate the softener beyond its rated capacity.

While sand filters are a more perfect means for clarifying turbid water, it has been found for railroad use that the excelsior filter gives entire satisfaction, costs less to install, less to maintain, and requires less attention from the operator.

OTHER PROBLEMS IN LOCOMOTIVE BOILERS

In the treatment of water for locomotives, there are several important problems to be given consideration other than the mere removal of incrusting solids. Even though the scale-forming ingredients have been removed, there may be difficulty from other sources. A clean boiler may be a fertile field for pitting and corrosion if the elements causing such troubles are present. This problem has and should engage the attention of railroad chemists for a long time. Iron dissolves in water with the evolution of hydrogen, provided the products of the reaction are removed. Otherwise the iron becomes polarized by the hydrogen and the reaction stops. If, however, oxygen is present in the water, the nascent hydrogen will combine with the oxygen and the reaction will continue as long as oxygen is available. Practically all natural boiler feed waters carry oxygen in solution. It is therefore continuously supplied to the boiler. While the amount is very small, ranging from perhaps 5 to 10 cc. per liter, it is nevertheless sufficient to do a great deal of damage.

If corrosion were uniform over the entire interior surface of the boiler, the trouble would not be so aggravated, but owing to the lack of uniformity of the metal, and the fact that there may be strains in flue sheets, fire box, knuckles and seams, the corrosion tends to localize and is then reported as pitting or grooving according to the shape of the corroded area.

The theoretical considerations upon which this thesis is founded are quite familiar and are ably borne out by experimental evidence. This excludes, of course, that corrosion due to acid water, which is not under consideration here.

Various attempts have been made to eliminate the oxygen from locomotive feed water without pronounced success. Open feed water heaters have been used for some time, and there is wide divergence of opinion as to whether or not they eliminate any considerable amount of oxygen. The indications are that much depends on the manner in which the feed water heater is handled. More definite results will be forthcoming when certain tests now running are completed. One of the best remedies at present for oxygen is to carry an excess of caustic soda in the treated water. It is important that this alkalinity be caustic rather than carbonate because there seems to be some evidence that at high temperatures and pressures, sodium carbonate breaks down into caustic soda, organic matter, and free oxygen.

This free oxygen would then be available as a corrosive agent. This is the explanation offered by J. H. Paul in his book on boiler chemistry.

At any rate the writers know that a boiler operating on water containing an excess of sodium carbonate at high temperature and pressure, develops caustic soda and organic matter, and shows some evidence of corrosion of the general, rather than the pitting type. A caustic alkalinity should therefore be maintained in the treated water to prevent this action.

Another difficulty met with in the use of treated water is foaming. Foaming is a function of the concentration of dissolved and suspended solids in the boiler. It may be relieved by frequent use of the blow-off, or the judicious use of anti-foaming compound. The best anti-foaming compounds depend upon castor oil contained in the liquid as an emulsion. A water completely treated by the lime-soda process, carrying a moderate excess of caustic alkalinity, should give less trouble from foaming than waters containing boiler compound or hard waters carrying high dissolved solids. This is because such water contains the smallest amount of dissolved and suspended solids.

Anti-foaming compound should be used sparingly, i.e., not until the water begins to give trouble; thus, the excessive use of compound may be avoided. The writers have seen engines where so much anti-foaming compound has been used that the boiler actually became compound dirty. It is more difficult to control the foaming after that point is reached. The advantages of water treatment in the removal of scale, the increased life of flues and fireboxes, the reduction of engine failures due to boiler troubles and the consequent improvement of railroad operating efficiency, are too well known to require individual comment here. Suffice it to say that with the present trend toward higher boiler pressures, longer engine runs, higher speeds and greater train loads, what is now considered efficient operation would be impossible without adequately treated water. Much has been written of water treatment, and much more has been said, but from the standpoint of the chemical engineer, the real problems of water treatment are solved by faithful field supervision and competent laboratory investigation and control.

SUCCESSFUL OPERATION OF FLUSH VALVES

By E. C. Groner[1]

The flush-valve or flushometer is not a new device. Flush-valves have been in use in various forms for thirty years or longer, but it is only during the last ten or fifteen years that they have been used in large numbers. At the present time, they are being installed at a rapid rate. No figures are available, but the total for the year 1925 must have exceeded 400,000 by a good margin.

They are virtually standard equipment for hotels, apartments, office-buildings, hospitals and clubs. They are being used more and more in public and parochial schools, universities, factories, warehouses and similar buildings. Their use in the smaller and less pretentious apartments and large private homes is greatly on the increase, and architects and owners are specifying them more and more for smaller houses having from one to three toilets.

The waterworks superintendents' professional interest in the flush valve is principally confined to those cases in which larger taps, service pipes and meters are used than are customarily furnished.

Since the flush valve, when installed on direct supply, draws its water from the main through the service pipe, as it requires it—that is to say, since each individual flush valve is not supplied with a storage tank—it is obviously necessary that the service and other piping between the main and each flush valve, shall be ample under the existing pressure to furnish the water to the flush valve at exactly the same simultaneous rates of flow as the flush valve must supply it to the closet bowl or other fixtures.

It is generally agreed that the rate at which water must be delivered to a closet bowl in order to secure a successful flush, is not less than 30 gallons per minute at a maintained pressure which depends upon the character of the closet-bowl used. The great majority of the closet bowls are of the floor-outlet type, that is, they stand upon the floor and discharge through the base. This type of bowl

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ordinarily requires a maintained pressure, or pressure during operation, of not less than 5 pounds per square inch.

Many waterworks superintendents are disturbed when asked to furnish service equipment sufficiently large to deliver water at the rate of 30 gallons per minute to the ordinary small dwelling or other building having about the same plumbing equipment as the small dwelling.

Fashions in plumbing, as in many other things, are changing. The standard of living is becoming higher. Two bath-rooms and sometimes three are now almost universally put into the better class dwellings in place of the single bath-room, of not many years ago. Laundry bibs, sill-cocks, shower-baths, garage sink and other cocks are being increasingly used. It is safe to say that the dwelling of the average American family has two or three times as many water-consuming fixtures as it formerly had. In addition, many fixtures, notably those of the wash-bowl, bath, sink and laundry are of larger size than formerly. I do not mean to say that the daily consumption of the average dwelling has increased in proportion to the increase in the number and size of plumbing fixtures, for it has not. How much it has increased, if at all, can be best answered by waterworks superintendents, but what I do mean to say is that the peak demand has gone up.

Tables 1 and 2 were published within six years from two very reliable sources, giving the demands of plumbing fixtures. With the exception of valve closets (closets with flush valve) all these fixtures are frequently left running for fairly long intervals of time. Overlapping frequently occurs, and the demands of overlapping fixtures may easily equal or exceed 30 gallons per minute, which has already been given as the generally accepted demand or rate of flow of the flush valve.

Owners are often annoyed by the interference of one fixture with the supply to another fixture. Adequate service and piping are required to prevent this. It should be borne in mind that the continuation of the flush of a flush valve is from about 6 to 12 seconds. This maximum demand of 30 gallons per minute is ordinarily the initial demand only, since the flush valve begins to close the instant the handle of the flush valve is released. A certain flush valve that is used in large numbers is put into action by the movement of the handle by the operator, and closes independently of any further action on the part of the operator after delivering a pre-determined amount of water to the closet-bowl.

TABLE 1

Flow of water at plumbing fixtures

KIND OF FIXTURES	FAIR FLOW PER MINUTE	GOOD FLOW PER MINUTE	EXCELLENT FLOW PER MINUTE
	gallons	*gallons*	*gallons*
Kitchen Sink Bibbs	2	4	6
Pantry Sink, High Goose Neck Cocks	2	2	3
Pantry Sink, Large Plain Bibbs	4	6	8
Vegetable Sink Bibbs	2	4	6
Laundry Tray Bibbs	4	6	8
Slop Sink Bibbs	3	4	6
Basin Cocks	2	3	4
Bath Cock (either hot or cold)	3	4	6
Shampoo Spray	½	1	2
Liver Spray	1	2	3
Shower Baths, 5-inch Rain Heads	2	3	4
Shower Baths, 6½-inch Rain Heads	2	3	5
Shower Baths, 8-inch Rain Heads	4	6	8
8-inch Tubular Shower Heads	6	8	10
Needle Baths	20	30	40
Manicure Tables	1	1½	2

By "Actual test at 30 pounds pressure." Buenger, Journal American Society of Heating and Ventilating Engineers, November, 1920. (See Cosgrove, Principles and Practice of Plumbing, p. 194.)

TABLE 2

Water drawn at fixtures (estimated)

FIXTURE	RATE OF FLOW, GALLONS PER MINUTE
Bath	10
Lavatory	5
Tank Closet	5
Valve Closet	30
Shower	5
Sink	10
Laundry Tub	10
Garden Hose	10

Copper and Brass Research Association (Sweet's Catalogue, p. 1457, 17th edition, 1922).

In view of the foregoing, present day conditions demand that service connections and other piping be made sufficiently large to deliver not less than 30 gallons per minute, and preferably not less than 35 to 40 gallons, under the pressures available, to any dwelling that might be classed as better grade.

It must be admitted that the piping connections required for flush valves or direct pressure in small buildings are somewhat larger in some cases than those usually furnished by the waterworks companies for such services. Flush valves are being used at a rapidly increasing rate in small buildings and the waterworks people are receiving more and more insistent demands for adequate service. These demands will have to be met sooner or later.

The main objections to these larger services seem to be two: greater expense for tap and pipe and for meter when used, and greater slippage or unrecorded flow with the larger meters than with the smaller meters. The answer to the first objection is that the owner who wants a larger service, will have to pay for it. The answer to the second objection is largely up to the meter manufacturers and to the inspectors of the water companies. Every meter, no matter how perfect its condition, has some slippage. The tightness of the fixtures determines whether or not this slippage of the meter shall result in unrecorded loss of water. Probably the worse offender in this regard is the tank closet.

On larger buildings the size of the service depends greatly on the peak load demanded by its fixtures. Schools, for instance, demand a larger peak load than any other class of buildings. Apartment buildings above six apartments can use the same size service as is normally used with low-down tank closets, but the piping inside the building is larger for flush valves. Hotels and large office buildings are generally fed from roof tanks or compression systems, and only require services large enough for suction lines for the pumps.

Each building, is a problem in itself. The size of service depends upon the minimum pressure available, peak load demand, elevation of highest fixture above street main, length of service pipe, distance of farthest fixtures from meter, and friction through tap, meter and piping.

When the waterworks superintendent is requested to furnish a service for a building, and he is in doubt as to the size required, it is up to him to have the architect or engineer who has charge of the building, furnish him with a piping layout.

THE ECONOMIC LIMIT OF DEEP WELL PRODUCTION[1]

By John W. Moore[2]

Since the water supply for cities, towns and factories throughout the middle west is largely obtained from wells penetrating the glacial deposits of water bearing sand and gravel and from porous bed rock, any question pertaining to the life or capacity of such wells is of importance.

Three of the most important factors concerning wells are, the first cost, the cost of pumping, and, perhaps most important of all, the life of the well or the period of time over which the well will yield continuously water at an undiminished rate.

Considering wells drilled in bed rock the question resolves itself into a financial one involving the first cost of the wells and pumps and will not be considered further at this time.

Wells penetrating water bearing sand and gravel in which the sand is very fine present problems for which satisfactory solutions have not yet been offered and when properly solved will indicate the number of gallons per minute or the rate of pumpage which such a well can be called upon to deliver safely without shortening its life or diminishing its usefulness.

Assuming that a well penetrating such a water bearing sand and gravel has been properly developed and equipped with a screen of rust resisting material, we then have two main questions which determine the undiminished yield of that well over a period of time. The first is the pumping level of the water in the well, that is creating a difference between the pumping level of the water and the ground water level. This difference, of course, depends upon the capacity of the deep well pump and can be controlled. The second question is the proper velocity or rate of flow of the water through the water bearing sand and gravel to the well.

The practical answer to this second question will indicate the number of wells and the rate of pumpage from each that should be installed in any sand and gravel deposit of whatever degree of fineness

[1]Presented before the Indiana Section meeting, February 17, 1927.

[2]Consulting Engineer, Indianapolis, Ind.

to produce a constant yield of water over a period of years equal to the life of the material of which the well and screen are constructed.

The pumping level of the water compared to the ground water level determines the head or velocity of the water through the sand to the well. This travel of the water to any central point may extend over considerable territory increasing in speed or velocity as the well is approached. The increasing velocity of the water approaching the well is apparently in many instances the ultimate cause of the failure of such wells.

The hydraulic law in reference to the carrying capacity of water in open channels operates no doubt in a modified form and controls the carrying capacity of water flowing through sand and gravel. As the water approaches the well through the sand at an ever increasing velocity the capacity to dislodge and carry forward particles of sand increases enormously and sand is drifted toward and through the screen into the well.

If it were a fact that all of the sand carried forward by the water would pass through the washed gravel surrounding the screen into the well there would be no problem to solve, since the water bearing sand and gravel would be continuously cleaned of the smaller particles thus allowing more free channels through which the water would travel with greater speed, increasing the capacity of all wells regardless of the fineness of the sand through which the water travels.

Unfortunately all of the sand carried forward by the water does not pass through the screen into the well. A physical obstruction seems to be offered to the carrying forward of the fine sand, by the washed gravel around the screen and by the further fact that the openings in the screen are partially obstructed by small gravel. This obstruction to the passage of the sand seems to act as a strainer through which the water passes with high velocity, but through which particles of sand of certain sizes will not pass at all. The lodging of each grain of sand increases the difficulty and within a short period of time wells located in such sand and gravel strata build up a wall of sand around the screen through which the water passes with an ever diminishing volume until the usefulness of the well is at an end.

It would seem that the only way to control this so called sand jamming around the screen of a well is to ascertain by experiment the rate of pumpage which a new well will safely stand and which will not produce a velocity of water through the sand sufficient to carry the particles of sand forward toward the well. I do not believe there is any

method by which this can be absolutely determined since the carrying forward of sand may be taking place slowly without any of the sand coming through the screen and showing in the water pumped from the well.

The question of the rate of pumpage in reference to the life of a well system installed in fine water bearing material should, in my opinion, be considered from the standpoint of any other permanent and important development, that is, the number and diameter of wells and the rate of pumpage from each well should be controlled by the first cost and by the length of usefulness of the wells.

The later question, that of the life of the wells, will be controlled by the rate of pumpage and therefore the rate of pumpage seems to be the key to the situation.

In order that I may give an actual example of the carrying capacity or the drifting capacity of water flowing through fine material and thus shortening the life of wells I wish to say that a city in the northern part of the state secures its water supply from sand similar to that found on the shore of Lake Michigan. For many years wells were made in this sand using a screen fine enough to hold back the sand and most of the water. Notwithstanding the fact that the wells had a maximum capacity of from only 30 to 70 gallons per minute it was sufficient to cause the sand to drift into the screen and thereby reduce the usefulness of the well within a very short time.

Three new wells, 10 inches in diameter, were constructed in this same sand around the screens of which washed gravel was deposited. One well was selected and pumped at the rate of 425 gallons per minute with very little sand being carried through the washed gravel and screen into the well. The maximum rate of pumpage was then determined to be not over 200 gallons per minute from each well and so far as my information goes these wells have continued to yield 200 gallons per minute during the last five or six years. I am confident that had the wells been pumped at 400 gallons per minute the sand would have drifted in and destroyed the usefulness of the wells within a comparatively short period of time.

The object of this paper is not to draw conclusions or make recommendations but it is hoped that those who have the opportunity and the inclination will take up this question with the view of determining in a practical way the economic rate of pumpage from wells made in fine material.

ELIMINATING A SOURCE OF ERROR IN THE COLORIMETRIC DETERMINATION OF MANGANESE

By A. C. Janzig[1]

In the determination of minute quantities of manganese by the colorimetric method, a source of error has been observed and a method devised to overcome it. The error has been noted particularly in waters which were highly colored or contained turbidity. The persulfate method as described in "Standard Methods of Water Analysis" (1) was used in these determinations.

The test in substance is: In hot nitric acid solutions containing silver cations, the reaction takes place as follows:

$$2Mn + 5S_2O_8 + 8H_2O \rightarrow 2MnO_4 + 10SO_4 + 16H$$

With interfering substances present, as carbonaceous matter or other insoluble material, a clear-cut comparison of the colors produced is impossible, unless they are filtered out. During the process of filtering off insoluble matter, it was noted that at times a loss of the manganese resulted, due to the deposit of manganese salts on the filter paper.

Certain writers (2) (3) have mentioned the difficulty experienced in completely oxidizing the manganese and also because of its instability during certain valence changes.

They mention the fact that carbon greatly delays the oxidation of manganese and that any other reducing agents should also be absent in the manganese test. According to Lord and Demorest (4) the presence of the silver salt is essential for, if not present, the manganese will be precipitated as manganese dioxide. If too much silver salt is present silver peroxide will precipitate and make the solution turbid. A. Travers (5) mentions the precipitation of manganese dioxide where considerable manganese is present, and that the oxidation to permanganic acid is usually incomplete. If a turbidity of silver chloride appears, Hillebrand (6) advises that the solution

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be agitated and filtered. No mention has been made by these authors of the possibility of a loss resulting in filtering off insoluble matter.

The writer found that when the manganese is completely oxidized to permanganic acid before filtering, no loss of manganese resulted. This was demonstrated by using water to which manganese in definite amounts was added. This is due to the greater stability of manganese in its highest valence, in which case it will not precipitate, but remain in a very soluble form.

In order to overcome the loss of manganese during the process of filtering, the writer carried out the analysis as follows: After the preliminary steps were followed as outlined in Standard Methods, complete oxidation was carried out and then the solution filtered in the presence of the oxidant, ammonium persulfate. Thus an excess of the oxidant was maintained which supplied residual oxygen, overcoming any reducing action which might take place.

Complete oxidation to permanganic acid is indicated by the development of the typical permanganate color which is reddish-purple and is often referred to as the "maximum" color.

The presence of an excess of the oxidant is shown by the evolution of gaseous oxygen.

CONCLUSIONS

In the determination of minute quantities of manganese by the colorimetric method the step which requires greatest care is the oxidation of the element to the heptavalent state. When carried out carefully, interfering substances may be filtered out without a loss of manganese, provided that residual oxygen is maintained during the process of filtration. The persulfate method has otherwise been found satisfactory and with the added precautions given, turbid or highly colored waters may be analyzed with the assurance that accurate results will be obtained.

REFERENCES

(1) Standard Method of Water Analysis, 6th Edition, 1925, p. 50.
(2) McPherson and Henderson: Gen. Chem., 1st Edition, p. 517.
(3) Prescott and Johnson: Qual. Analysis, 5th Edition, p. 177.
(4) Lord and Demorest: Metallurgical Anal., 4th Edition, p. 89.
(5) Travers, A.: Ann. Chem., 6, 56–86 (1926).
(6) Hillebrand, W. F.: Bulletin 700, U. S. Geo. Survey, p. 138.

COMMENTS ON THE MANUAL OF WATER WORKS PRACTICE[1]

By J. W. Ellms[2]

The value of any technical book depends upon the character and amount of information which it contains. The authors who compiled the Manual of Water Works Practice were limited both in the kind and quantity of material which they could use. As stated in the preface, "It has been manifestly impossible to obtain complete agreement on all subjects, particularly those of more detailed technical character." The object has been to "reflect the principles and practices of a fairly adequate cross-section of practitioners in the multiplicity of water works activities." On this basis, the writer feels that the authors have succeeded fairly well.

In any general criticism of the Manual the question may be raised as to whether it has been found satisfactory to its readers, i.e., have those who have used it found that it contained the information for which they were seeking. Probably no two users of a technical book will have the same opinion of its adequacy or inadequacy. Each may find that the particular information for which he may be hunting is not in the book. To a specialist in a particular field, the description and discussion given to his subject may seem quite elementary, while to another not versed in this particular branch of the art, it may appear very informative. If an accurate summary of opinion of the Manual could be obtained, the writer believes that those who specialize in some one field of water works practice would regard the book as more or less inadequate in their own particular branch of work, but generally satisfactory in other respects.

The problem, therefore, becomes one of satisfying both classes of readers. Probably this cannot be done without considerably enlarging the contents of the book and possibly making more than one volume. Financial considerations naturally enter into such a proposition. However, the writer feels that the Manual as it now stands,

[1] Presented before the Central States Section meeting, September 16, 1927.

[2] Engineer of Water Purification and Sewage Disposal, Cleveland, Ohio.

subject to such modifications as seem desirable, may become the basis for a real hand-book of water works practice, which it is believed is the sort of book that all readers desire.

The writer was asked to discuss especially the chapters on the "Treatment of Water." Criticism of any of the topics under this general subject is difficult as long as the authors' objective was presumably a more or less generalized presentation of each subject. Addition or withdrawal of a small amount of subject matter does not materially modify the character of the Manual. However, a very few brief comments on the subject of the "Treatment of Water" as presented in the Manual may be of some interest.

On the 790 pages in the Manual, 16 to 17 per cent of them are devoted to the treatment of water. Out of the six major divisions, excluding the Appendix, this proportion of the whole is perhaps a fair allotment of space. Of the fourteen topics discussed in the 130 odd pages dealing with the "Treatment of Water," the following approximate proportions of the space are given to the several topics:

	Percentage of space occupied
Self-purification of streams, lakes, etc	9.4
Algae	5.4
Chlorination	12.1
Aeration	4.0
Settlement	3.1
Coagulation	7.3
Rapid sand filtration	12.7
Slow sand filtration	11.2
Double filtration	3.9
Covering reservoirs	1.5
Removal of iron and manganese	3.7
Water softening	9.6
Ultra-violet light and ozone	2.3
Iodization	13.5

The seven subjects, namely, self-purification, chlorination, settlement, coagulation, rapid sand filtration, slow sand filtration and water softening occupy about two-thirds of the text. To iodization, 13.5 per cent of the space is given, leaving about 21 per cent of the text for the remaining six subjects.

The following comments on six of the principal topics may be of value in any revision of the Manual which contemplates maintaining its present character.

Self-purification of streams, lakes and reservoirs. It is difficult to

improve on the language and the thoroughness with which the late Prof. Geo. C. Whipple has explained these natural processes. Certain phases of the subject, however, have received such a thorough exposition by the scientists of the United States Public Health Service, that some summary of the quantitative measurements of de-oxygenation, reaeration and their relation to bacterial pollution would be valuable to the readers of the Manual.

Chlorination. This important subject has been well treated and is entitled to all the space which it occupies. The subject of de-chlorination, however, is hardly more than mentioned in the Manual. This process may not be at present common practice in American water purification plants, nevertheless, there is considerable likelihood of its increasing use. The methods employed in using various anti-chlor compounds, as well as other methods of dechlorinating treated waters, together with the efficiencies and costs, would be helpful to users of the Manual.

Rapid sand filtration. The problem of filter plant loading is discussed in a very general way in the Manual, but its importance warrants considerably more space being given to this subject. By the time another revision of the Manual is made, it is hoped more data may be available for fixing the bacterial standards which water purification plants may be reasonably expected to attain.

Coagulation. The subject of coagulation is well and concisely treated. The employment of alkali aluminates under various trade names for coagulating purposes should receive some consideration, as they have been found useful under certain conditions.

Slow sand filtration. There seems to be no mention of the machine methods for cleaning slow sand filters in which traveling washing machines of the Blaisdell type are used. It is understood that the results of their employment in Philadelphia plants have been quite satisfactory.

Water-softening, zeolites. More might be introduced under this topic on the practical efficiencies of different zeolites used in water softening, and on the costs of the process when compared with the lime-soda process.

Iodization. To this subject there is too much space allotted. It takes up 13.5 per cent of the 130 odd pages given to the treatment of water, or more space than is given to any other topic. It cannot be justified on the score of American practice. While it is a fair presentation of a controversial subject, the extended article printed

could be made much shorter and still give the essential facts. At the most not more than a page or two should be allowed for discussing the entire subject.

In general, the absence of drawings, cuts and diagrams to illustrate and explain the text in the "Treatment of Water" is a real drawback to its usefulness. It is, of course, recognized that the insertion of such material increases the cost. Nevertheless, if readers are to be satisfied, expansion of the Manual into a real hand-book or treatise on American water works practice, is inevitable.

STUDIES OF THE EFFICIENCY OF WATER PURIFICATION PROCESSES[1]

Studies of the bacterial efficiency of municipal water purification plants have formed a logical part of the stream pollution investigations undertaken by the Public Health Service under authority of an act of Congress of 1912. These investigations, having dealt principally with the public health aspects of stream pollution, the safety of public water supplies, and, more especially, the relation between the sanitary quality of such supplies and the permissible degree of pollution of their sources, have been subjects of basic importance for inquiry. A report on these studies by Sanitary Engineer H. W. Streeter, has just been issued as Public Health Bulletin No. 172.

The main objectives of the studies dealt with in this report are the following:

a. An appraisal of the bacterial efficiency of well-designed and well-operated municipal water purification plants treating sewage-polluted river waters; and

b. A determination, if possible, of the maximum limit of bacterial pollution of river water supplies, as delivered for treatment, consistent with the production of effluents conforming to specified standards of bacterial quality.

In the latter connection, reference is made to a limiting standard, recommended in 1914 by the International Joint Commission, defining the maximum permissible density of B. coli in raw waters taken from the international boundary waters of Canada and the United States for purification.

During a period of 13 months in 1915–16, the Public Health Service undertook a preliminary observational study of the Cincinnati and Louisville filtration plants, taking their raw water supplies from the Ohio River. From this study a well-defined relation was found to exist between variations in the bacterial quality of the raw water and concurrent variations in the quality of the effluents obtained at successive stages of treatment, including the final stage.

[1]Reprinted from United States Public Health Reports, Vol. 42, No. 42, October 21, 1927.

From this relationship it was indicated that the maximum B. coli index of the raw water, consistent with the production of a final (chlorinated) effluent conforming to the original United States Treasury Department drinking water standard, was about 630 per 100 cc. The corresponding limit fixed by the International Joint Commission raw water standard was 500 B. coli (index) per 100 cc.

Further studies of the problem were delayed, owing to the war, and were not resumed until 1923, when a collective survey of 17 municipal water-filtration plants was undertaken, 10 of these plants being located along the Ohio River and the remainder on other rivers in the Eastern and Middle Western States. From this survey, the following tentative conclusions were drawn:

1. Under normal conditions of their operation, all of the plants studied have shown a fairly definite relationship as existing between variations in the bacterial quality of their raw-water supplies and concurrent variations in the quality of effluents produced by them at successive stages of treatment.

2. In general, the nature of this relationship has been found to be expressed by the equation $E = cR^n$, in which (R) represents the bacterial content of the raw, or influent, water, (E) that of the effluent water, and (c) and (n) empirical constants.

3. The over-all efficiency of bacterial purification, when expressed in terms of B. coli removal, appears to be influenced to a relatively slight, if any, extent by changes in temperature and other seasonal conditions, or by variations in raw-water turbidity, all other conditions being equal.

4. According to the best statistical evidence afforded by the surveys, as based on the mean performance of the 10 Ohio River plants, the maximum B. coli index of raw river waters of the Ohio River type, consistent with producing a final chlorinated effluent conforming to the revised Treasury Department standard, approximates 5000 per 100 cc. The corresponding maximum raw-water B. coli index consistent with producing *unchlorinated* effluents meeting the same standard was found, however, to average as low as 60 per 100 cc. Plants more highly elaborated than the average, such as those equipped with double-stage sedimentation and coagulation, appear to be able to produce satisfactory chlorinated effluents from river waters having a B. coli index somewhat in excess of 10,000 per 100 cc.

5. Water purification plants operated along the Ohio River are

unable, under existing conditions of pollution of this stream, to produce unchlorinated effluents conforming, as an average, to the revised Treasury Department B. coli standard, though they are able, by the continuous and effective use of chlorine, to produce, for a large part of the time, chlorinated effluents meeting this standard. On the basis of the average limit of tolerance above stated, two of the Ohio River plants surveyed, located, respectively, at Ironton, Ohio, and Ashland, Ky., were indicated as being overburdened by excessive bacterial pollution of the river in the zone from which their raw-water supplies are obtained.

6. With one exception, all of the seven plants surveyed, located elsewhere than on the Ohio River, were able to produce satisfactory final effluents from raw waters having a B. coli index not exceeding 5000 per 100 cc. Two plants of this group, located, respectively, at Albany, N. Y., and Chester, Pa., were shown to be overburdened by excessive raw water pollution, on the basis of the criterion above given.

Aside from those above stated, no final conclusions can be drawn from the surveys described until their results have been checked against the results of experimental studies in progress at this time, and possibly also further surveys of full-scale plants located in other sections of the country. Systematic and well-correlated observations of full-scale plant performance thus far have included no examples of plants found west of the Mississippi River and but one example of plants treating water from the Great Lakes.

Public Health Bulletin No. 172, containing the full report, may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at $1 per copy.

A STUDY OF THE POLLUTION AND NATURAL PURIFICATION OF THE ILLINOIS RIVER[1]

A Review by T. C. Schaetzle[2]

For a number of years the United States Public Health Service has been engaged in studies of the pollution of inland streams. Broadly speaking the objectives of these studies have been:

1. To develop practical procedures for the measurement of stream pollution and suitable forms for expression of the degree of pollution encountered.
2. To ascertain the probable effects to be anticipated from increasing pollution loads and to determine the power of streams to recover from such imposed burdens, through the operation of natural agencies.
3. To observe the effects of stream pollution on the public health, as reflected in the quality of water supplies, procurable from polluted sources and as influenced by methods of removal and disposal of domestic sewage and industrial wastes.

The studies discussed in Bulletin No. 171 are concerned primarily with the second of these objectives, the Illinois River being selected for the investigations.

Extensive studies carried on during the years 1921 and 1922 by the United States Public Health Service, in coöperation with the Sanitary District of Chicago, are discussed in this comprehensive report of 6 chapters. The features of the Illinois River and its watershed; the population of the Illinois River watershed, and sources of pollution of the river; hydrometric measurements; methods of procedure in field and laboratory studies; sanitary chemical analyses; and bacteriological studies are reviewed in detail.

The Illinois River watershed comprises a total area of 28,334 square miles and is a part of the eastern Mississippi drainage basin. It is comparatively flat. The natural drainage area has been increased by the construction of the main drainage canal of the Sanitary District of Chicago which withdraws water from Lake Michi-

[1] Public Health Bulletin No. 171, May, 1927, by J. K. Hoskins, C. C. Ruchhoft and L. G. Williams.

[2] Senior Assistant Sanitary Engineer, State Department of Health, Baltimore, Md.

gan and discharges into the head waters of the Illinois River near Joliet. As this canal transports the major volume of sewage from the Sanitary District of Chicago considerable pollution reaches the head waters of the stream. Of a total sewered population on the watershed of approximately 3,400,000 over 80 per cent contributes sewage through the canal in addition to a large portion of industrial waste pollution. The latter, in terms of population equivalents, amounts to about 67 per cent of the total industrial waste pollution on the watershed.

During this study the average rate of discharge from the main drainage canal was 8650 cubic feet per second. This amounts to more than 30 per cent of the total discharge of the Illinois River at the lowest observation station 26 miles from the mouth, but varies with the run off from the drainage area. These percentage figures have gone as high as 70.7 per cent and as low as 9.3 per cent, the latter during flood conditions. To observe the chemical and bacterial content of the river throughout its entire length sampling stations were located at established points not exceeding 25 miles apart. Collections were made at these stations 3 or 6 times weekly. Additional samples were collected from the mouths of the larger tributaries. These collections and examinations were continued over a period of fourteen months. The chemical analyses consisted of determinations of turbidity, alkalinity, dissolved oxygen, both immediate and after five days incubation at 20°C., suspended matter, free ammonia, Kjeldahl nitrogen, nitrogen oxides and oxygen consumed.

The bacteriological examinations consisted of the determination of the bacterial counts on agar plates incubated at 37°C. for twenty-four hours, on gelatin plates incubated at 20°C. for forty-eight hours and an estimation of the B. coli.

The outstanding results of this investigation may best be indicated by the following quotation from the bulletin:

> The sanitary chemical analyses afford a means of estimating roughly the extent of dilution of Chicago sewage in the main drainage canal by water drawn from Lake Michigan. From these data it appears that from 7 to 8 per cent of the flow in the canal is sewage of normal strength diluted with lake water in amounts from 93 to 92 per cent. . . . . As a whole it may be concluded that the sanitary chemical determinations are not sufficiently sensitive to record, accurately, progressive changes that occur in the waters of polluted streams as they flow from point to point. Such examinations are of value, however, in a general way for comparative purposes.

The oxygen dissolved and the oxygen demand determinations are more sensitive indices of the existing condition of organic substances that cause nuisance in polluted watercourses.

The numbers of bacteria in water, especially those of the B. coli group, are generally considered an index of its sanitary condition. Being exceedingly sensitive to various factors of environment, it is of considerable interest to have definite knowledge of the rates at which they disappear in polluted streams or, in other words, the nature and extent of occurrence of natural bacterial purification under various seasonal and physical conditions to which the stream is subjected. The bacteriological observations were, therefore, made with this object in view and for the further purpose of comparing such results with those obtained in previous similar studies of the Ohio River.

Observations, continued throughout an entire year, of the bacterial content of the Illinois River at definitely established sampling stations have supplied sufficient information to evaluate the excessive bacterial pollution of the river by the main drainage canal of Chicago. The density of bacteria is very rapidly reduced in the upper reaches of the river, and, progressing downstream, at slower rates until at Peoria the average numbers growing on agar seldom exceed 4000 per cubic centimeter in summer and 2000 in winter. Pollution contributed by the Peoria district again imposes a considerable bacterial load on the stream, which likewise tends to diminish at subsequent downstream points, until at the mouth the bacterial content of the Illinois compares quite closely with that of the Mississippi River at the junction.

The rates at which the bacteria decrease are dependent on seasonal temperatures, being much more rapid in summer than in winter.

This bulletin presents an excellent compilation of hydrometric, chemical and bacteriological data, together with a large number of charts of which the ones on bacterial purification are especially interesting and instructive. The sketches of the sample collector and sample shipping case as shown in this bulletin seem to be well adapted for the purpose for which they were designed and should be helpful to others engaged in similar studies.

The charts showing the sampling stations and profile along the entire Illinois River, the summarized description of the river prisms, the detailed discussion and charts showing the procedure used to determine the time of flow between sampling stations, the table on estimated average amounts of certain constituents in various industrial wastes per unit of raw material or product, and the detailed chemical and bacterial tables and charts are among the numerous features of this report which indicate the painstaking and thorough manner in which this study was carried out.

The bulletin is concluded with two appendices, one of which is on

the preservation of samples for sanitary chemical analysis. The data and discussion presented should be especially interesting to sewage chemists. Relative to the use of preservatives the following statement is made: "On the whole it appears that the preservation of samples by acidifying with about 1000 parts per million of sulphuric acid is a very simple and highly effective method of procedure."

Charles Henry Rust

Died September 22, 1927

Charles Henry Rust was born at Great Waltham, Essex, England, on December 25, 1852. He was educated at Brentwood Grammar School and came with his family to Canada in 1872. After his arrival in Canada he spent five years on railway location and then entered the services of the City of Toronto attached to the engineering staff under the late Frank Shanly, who was then City Engineer.

In 1881 Mr. Rust was advanced to the position of Assistant Engineer by Redmand J. Brough then City Engineer and Manager of Water Works. In 1883 he was appointed Assistant Engineer in charge of sewers, which position he occupied until 1891. During this period he held also the office of Principal Assistant Engineer. In 1892 Mr. Rust was appointed Acting City Engineer until the appointment of the new City Engineer, E. H. Keating, in July of the same year. This led to his immediate appointment as Deputy City Engineer, holding this office until February 1898 when, upon the resignation of Mr. Keating, he was appointed City Engineer and Manager of the Water Works.

Mr. Rust's greatest interest in municipal engineering always centered around the problems of sewerage and water supply, and under his administration in Toronto many improvements pertaining to better sanitary conditions were originated and carried out. It was during his tenure of office as City Engineer that the cast iron supply main which connected Lake Ontario with the main pumping station was replaced by a tunnel a mile in length, excavated in rock beneath Toronto Harbor; a new intake was installed at a depth 60 feet below the surface of Lake Ontario, and a slow sand filtration plant, with a capacity of 40 million gallons per day, was constructed on the Island separating the harbor from the lake waters. The water supply system in the city was also largely extended to meet the increased demand caused by rapid growth of the city. At about the same time a complete main drainage system and sewage purification plant was installed for the further protection of the water supply of the city.

His duties also included reports on many schemes, which, while requiring a great deal of time and much painstaking study, were never brought to fruition.

He reported at times on water works and sewerage problems for neighboring municipalities and occasionally acted as an arbitrator. Although his services were frequently in demand as a consultant and expert, his routine duties occupied so much of his time that he was unable to accede to many requests for professional advice.

In 1912 Mr. Rust resigned the position of City Engineer of Toronto to accept the position of City Engineer of Victoria, British Columbia. His desire to make this change was heightened by the interesting problems presented by the proposed installation of a new municipal water supply from Sooke Lake. While in Victoria he was requested by the Government to report in conjunction with R. H. Thompson upon the Greater Vancouver Sewerage Scheme. He also reported for the Municipality of Coquitlam upon the Second Narrows bridge, near Vancouver. Six years later he returned to Toronto and became connected with the Toronto Street Railway and Toronto Electric Light Company until these utilities were absorbed by the City. He was identified with the Toronto Hydro Electric System until his death.

Mr. Rust in 1887 was elected as one of the first members of the Canadian Society of Civil Engineers, now the Engineering Institute of Canada. He always took a great deal of interest in its affairs and served in various capacities until in 1911 he was elected President of the Society. In 1902 he was elected president of American Society of Municipal Improvements.

Mr. Rust was elected a member of the American Society of Civil Engineers in 1899 and served as vice-president during the years 1913–1914. For many years he was a member of the Royal Canadian Yacht Club and the National Club of Toronto.

In 1879, Mr. Rust married Alice Preston, who survives him. His kindly and affectionate disposition endeared him to all those who were privileged to know him intimately. His mature judgment, unfailing courtesy and tactful manner fitted him for the numerous high positions which he held in the engineering profession and made him loved and respected by his many business associates.

For many years Mr. Rust was an active member of the American Water Works Association, serving on the Executive Committee during the years 1916, 1917 and 1918. He had joined as an Active Member in 1903.

SOCIETY AFFAIRS

CALIFORNIA SECTION

The California Section Convention at San Jose on October 5, 6, 7 and 8, 1927 again proved a record breaker both in attendance and interest. With the high water mark of 387 to shoot at, set at the San Diego Convention in 1926, San Jose staged the livest and most enthusiastic meeting yet held with a registered attendance of 564 members and guests. Twenty-two members and guests outside of this state honored the convention with their presence, coming from as far away as Canada, New York and Alabama.

Weather conditions proved ideal, warm and balmy in this garden spot of California and did much to make an ideal setting both for the field demonstration staged in the open and for the many pleasure trips arranged especially for the ladies.

The two convention headquarters hotels were completely sold out and the overflow taxed the housing capacity of the other hotels in the city.

The regular 3-day session was extended to 4 days as a trial innovation. The wonderful success that followed gives assurance that this will be a regular feature in the future. The extra day was designed for a twofold purpose, first, a golf tournament and second, a greater opportunity for the members and guests for personal contact and more leisure to review the manufacturer's exhibits. Two hundred and twenty-five registrations at the convention hall in addition to 60 golfers out on the fairways on this opening day proved the tremendous interest created. The winner turned in two rounds of 74 and 72 on the San Jose Country Club links, a course of full championship length.

The San Jose Water Works acted as local hosts and together with the exhibitors were untiring in their efforts to put the convention over the top and certainly succeeded in making the meeting interesting, worth while, instructive and enjoyable to members, guests and exhibitors alike.

The exhibit and convention meetings were held at the Scottish

Rite Temple. The spacious auditorium housed some 52 exhibits, using up all available space. Exhibits were all completed and in place prior to the convention. These were attractive and covered all lines of equipment available to water works practice. Constant crowds from the opeinng day to the windup testified to the intense interest displayed in this feature.

The Convention meetings were held in the lodge room of the temple which proved ideal for the occasion. Two hundred seventy-five delgates attended these sessions. Papers were interesting, short and snappy and several symposium sessions gave opportunity for a great number of the delegates to enter the discussions.

A practical field demonstration of modern water works practice was staged in St. James Park just opposite the convention hall. This was an innovation designed to give all water works men an opportunity to visualize standard practice methods and some especially difficult and unusual service connection problems. Exhibits and demonstrations covered the general ground of cutting and welding fittings, making ½ to 12 inch taps on mains under pressure, gas and electrically welded taps, cement caulked joints, insulated services in galvanized screw, brass and cast iron pipe, electrolysis bonding, solder taps and a 500-pound pressure test on cast iron pipe with caulked cement joints.

This innovation created so much enthusiasm and interest that it is planned to make a demonstration of this character a regular feature of future convention meetings.

On Thursday evening the business dinner was held at the Hotel Sainte Claire and 256 members and guests attended. Reports of retiring officers were presented and the following officers elected for the ensuing year: Chairman, Joseph R. Ryland, to succeed Samuel B. Morris; Vice-chairman, John Burt to succeed Joseph R. Ryland; Secretary-Treasurer, Wm. W. Hurlbut to succeed Paul E. Magerstadt; Executive Committee, Charles Olmstead succeeding John Burt and W. F. Goble succeeding Peter Diederich. In view of the National Convention of 1928 being held in San Francisco next June, it was voted to merge the California Section meeting next year with the national meeting.

The convention was honored by the presence of Beekman C. Little and his family. Mr. Little favored the occasion with an address and brought a hearty message of encouragement and good will from the national officers, and spoke at length on the hopes and plans for the San Francisco convention.

Mr. Clay Miller, former President of the San Francisco Chamber of Commerce, delivered an interesting address paying tribute to the water works engineer and crediting and pointing out how great a part of modern comforts, health, convenience and prosperity are attributable to the technical skill and accomplishments of water works engineering and construction. In concluding, Mr. Miller promised to enlist the whole machinery of the San Francisco Chamber of Commerce in advertising and furthering plans for and assisting the National Convention at San Francisco next year.

The exhibitors' dinner dance was held Friday evening at the Hotel Vendome. Four hundred and forty-four members and guests sat down to dine. The famous "Orpheus Quartet" of Los Angeles sang several selections. Arthur Terry, a talented "cowboy" monologist, entertained after dinner with a clever appropriate patter concerning officials and notables present. An enjoyable dance followed until the small hours of the morning.

On Saturday the San Jose Water Works entertained with an auto trip and barbecue. Two hundred and eighty members and guests participated and had a most enjoyable outing.

The ladies turned out in force for the convention with a total registration of 129. During their free time they were entertained with a theatre party, a country club luncheon and a trip to Stanford University where a special treat was provided in the shape of an organ recital in the famous Stanford University Chapel.

The technical program during the convention follows: "Description of San Jose Water Works System," by Joseph R. Ryland. "Centrifugally Cast High Pressure Concrete Pipe Line for the City of Riverside," by Edward R. Bowen. "Flow Tests from Fire Plugs," by R. C. Stange. "Present Practice in Cross Connections," Symposium. "Removal of Sulphur from Well Water," by Arthur Taylor. "Watershed Protection," Symposium. "Water Main Installation Methods," Symposium. "Various Water Works Jobs for 1927," by I. E. Flaa.

PAUL E. MAGERSTADT,
Ex-Secretary.

ABSTRACTS OF WATER WORKS LITERATURE

FRANK HANNAN

Key: American Journal of Public Health, **12:** 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the Journal.

The Problem of Concrete Deterioration More Especially with Reference to Its Use for Conduits and in Lining Pipe. JOHN R. BAYLIS. Am. Soc. Mun. Imp., November 8, 1926. Discusses the fundamental reasons for changes taking place in Portland cement concrete after it has set and specific instances of its deterioration in conduits and pipe lines. Hydrated Portland cement will give up calcium hydroxide to the saturation point of the compound when submerged in water and 90 per cent of the calcium can be extracted by submergence in natural waters. A discussion of the characteristic compounds of hydrated Portland cement and a method of determining the conditions causing this change in composition after exposure to air and water are given. The purpose of calcium sulfate in cement is stated to be to control the set and slow the process of hydration. The exact compound formed by the combination of sulfur trioxide and calcium aluminate when hydrated is unknown, but it is believed to be either a solid solution or surface adsorption thereby forming a film over the aluminium compounds retarding the hydration speed. A gradual carbonating of the alkalies in the cement takes place. This phenomenon occurring near the surface makes possible the use of cement for exposed structures since it prevents the slow leaching of the alkalies from the mass by the penetration of water. The presence of calcium sulfo-aluminate needle crystals in concrete is shown to be a contributing factor in concrete weakening due to the rearrangement of the particles forming the mass with resultant pressure within itself. The statement is made that a water having a sulfur tri-oxide content greater than 4 p.p.m., which includes most natural waters, will give up sulfates to the concrete if the calcium hydroxide component is reasonably high. These conditions indicate that the decomposition of *old* concrete is not necessarily due to poor workmanship or materials but can be caused by chemical changes. A discussion of the use of cement in lining of iron water mains is given and suggestions offered as to the effective thickness of the coat for protection of the pipe in corrosive and non-corrosive water. Photographs showing cement under conditions as discussed are given together with curves illustrating analytical data.—*Edward S. Hopkins.*

Progress of Electrometric Control Methods in Industry. H. C. PARKER. Ind. Eng. Chem., **19:** 660–7, 1927. The advantage of electrometric measurements is given. Instruments of this type have found application, not only for the usual acidimetric and oxidimetric analyses of the scientific laboratory,

but also in the practical control of such industries as mercerizing cotton, manufacturing sulfuric acid and sugar, and in studies of waste disposal, water works, and power plants. Apparatus suitable for such work is described.—*Edward S. Hopkins* (*From Chem. Abst.*).

Manganese Interference in the Ortho-Tolidine Test for Available Chlorine. EDWARD S. HOPKINS. Ind. Eng. Chem., **19**: 744–6, 1927. Attention is called to the fact that unstable salts of manganese will oxidize *ortho*-tolidine and produce the characteristic yellow color. Entire reliance cannot be placed upon this test for available chlorine if manganese is present in a water supply. The possible chemical formulae for manganese under such conditions are discussed.—*Edward S. Hopkins.*

Effect of Velocity on Corrosion of Steel under Water. R. P. RUSSELL, E. L. CHAPPELL and A. WHITE. Ind. Eng. Chem., **19**: 65–8, January, 1927. A review of previous work and of theoretical factors is presented. Tests on pieces of steel suspended in water in steel tubes of varying diameter were conducted over periods of time running from 48 hours to 2 weeks. This work indicates that the corrosion of steel under water increases with increasing velocity of water provided metal is covered with rust.—*Edward S. Hopkins.*

Use of Lime in Water Softening and Water Purification. CHARLES P. HOOVER. Ind. Eng. Chem., **19**: 567–70, May, 1927. In addition to its softening qualities, attention is called to the sterilizing action of excess lime in water treatment. A selective action for B. Coli is suggested, tables being given to show that after 5 hours contact using excess causticity this organism is killed. Elimination of color, iron, turbidity, and odor and increased sedimentation efficiency are claimed. Modern practice is to soften to point of precipitation of magnesium and then add excess of carbon di-oxide gas to precipitate calcium hydroxide followed by filtration. Gas is obtained by burning coke, oil, etc. Possible also to use "split" treatment, neutralizing excess lime with carefully controlled portions of raw water. Operating cost of such treatment is given.—*Edward S. Hopkins.*

Natural Sodium Bi-Carbonate Waters in the United States. W. D. COLLINS and C. S. HOWARD. Ind. Eng. Chem., **19**: 623–4, May, 1927. A review of about 8800 analyses is given. The Atlantic Coastal Plain is considered the best area for sodium bicarbonate water. A chart is given illustrating data given.—*Edward S. Hopkins.*

Treatment of Water to Prevent Corrosion. JOHN R. BAYLIS. Ind. Eng. Chem., **19**: 777–81, July, 1927. The possible treatment of a water supply to prevent corrosion is presented and a review of current thought upon corrosion is given. The question of protective coatings for iron pipes is discussed and it is shown that zinc will be dissolved in water at a pH of 6.5 or less but does not corrode very readily at a pH of 7.5. Corrosion of a fresh iron surface is not prevented even by an alkaline water, but such a water will build a system of protective coating and finally retard it completely. Water at solubility

equilibrium of calcium carbonate and containing over 25 p.p.m. alkalinity will not corrode pipe. A curve is given showing various concentrations of alkalinity for pH values of solubility equilibrium of calcium carbonate. Water above or on this curve will build up protective coating for pipe, below it, it will be corrosive. Pitting is discussed and data are presented to show that a pit is always acid. Cement lined pipe will give longer life than the usual bituminous coatings, but corrosive water will eventually destroy this protection. The evidence produced indicates that water containing alkalinity to the point of saturation on the calcium carbonate curve offers fairly good protection to iron pipes and if kept near that curve will not fill lines with incrusting material. —*Edward S. Hopkins.*

Cement Lined Water Mains. HARRY Y. CARSON. Ind. Eng. Chem., **19:** 781–3, July, 1927. This paper considers the factors in water supplies causing "red water" conditions and discusses value of cement lined pipe to prevent internal corrosion of water mains. Replacement of calcium hydroxide by ferric hydroxide is believed to prevent erosion of the cement and give indefinite life to the pipe. Methods of manufacture are discussed and data after about 50 years of service in corrosive water are given.—*Edward S. Hopkins.*

Recarbonation of Softened Water. CHARLES P. HOOVER. Ind. Eng. Chem., **19:** 784–6, July, 1927. Water softened with lime may deposit calcium carbonate in pipe lines with decrease of capacity, or choke filter beds by formation of "balls" resulting in poor operating conditions. Such a condition is overcome by adding carbon-dioxide to such a supply thereby converting the slightly soluble calcium carbonate to the highly soluble calcium bi-carbonate. Such practice is being conducted in numerous places in this country, operating conditions of certain plants being quoted together with a description of the apparatus, as well as a comparison of cost of various fuels for the production of carbon di-oxide upon a plant scale.—*Edward S. Hopkins.*

Surface Waters of North Carolina. MARGARET D. FOSTER. Ind. Eng. Chem., **19:** 855–6, July, 1927. A detailed analysis of the surface waters of this state and a table showing these data in a convenient form are given.—*Edward S. Hopkins.*

Paradox of Corrosion and Protective Film Theory. T. FUJIHARA. Ind. Eng. Chem., **19:** 1008–9, September, 1927. A microscopical study indicates that pure metals are more corrodible when exposed to a drop of water than the more impure commercial variety. It is concluded that initial corrosion is faster with impure iron than with the electrolytic, but as protective films are formed the corrosion is retarded. Microphotographs and curves are presented.—*Edward S. Hopkins.*

Color Diffusion in Endo Agar. ELIZABETH F. GENUNG and LUCY E. THOMPSON. Jour. Bact., **14:** 139–56, August, 1927. Interesting information concerning the reliability of Endo medium for differentiation of B. coli, B. aërogenes,

and B. typhosus is given. The failure of this medium is due to the re-appearance of color upon standing, producing false reading of the organisms. Studies were made in an attempt to explain this condition. Commercial peptones were investigated; some brands produced this return of color, others did not. A pH value of 7.3 is suggested as the correct reaction value. The theory of the test as given is that color production in the colony of the colon group is due to an acid-aldehyde reaction and not to the presence of lactic acid alone.—*Edward S. Hopkins.*

Investigations of Chemical Reactions Involved in Water Purification. Illinois State Water Survey, Bulletin **22**: 133 pp., 1920–25. Titration curves, by means of the hydrogen electrode, are given for some common carbonates and bicarbonates, and with the same equipment the precipitation of magnesium, calcium and aluminum has been studied. The solubility of aluminum hydroxide, determined over a wide pH range, gave data for a recalculation of the solubility product and the isoelectric point, giving a minimum solubility range of pH 5.5 to 7.8. A pH of 6.0 favored maximum color removal. From two surveys of filtration plants in Illinois, data were collected on residual alumina with relation to pH, the minimum amounts being found between pH 6.0 and 7.8. Samples from various filtration plants were analyzed with particular attention to the chemical composition of the alum floc, and an experimental filter was operated over a wide pH range to supplement the laboratory and field data. In addition, the solubility product of magnesium hydroxide was determined, and studies are reported on the effect of heat in a commercial lime-soda softener.—*A. M. Buswell.*

The Mineral Waters of Basilicata. Luigi Parlati. Il notiziario chim.-industriale **1**: 116–7, 1926. From Chem. Abst., **20**: 2474, August 10, 1926. Continued investigation shows numerous springs not already described. Some of these are utilized therapeutically.—*R. E. Thompson.*

Chemical and Chemico-Physical Investigations of the Water of the Baths of Roselle, Grosseto. R. Nasini, C. Porlezza and A. Donati. Ann. chim. applicata, **16**: 99–126, 1926; cf. C. A., **19**: 366. From Chem. Abst., **20**: 2474, August 10, 1926. Composition of water given. Aside from possible value of mineral ingredients, its temperature (38.5°), its radioactivity (0.0402 Maché units per liter) and its free carbon dioxide content (86.66 p.p.m.) may account for the therapeutic value.—*R. E. Thompson.*

Do Spring Waters Containing Carbon Dioxide and Hydrogen Carbonates Activate Amylases? M. Loeper and A. Mougeot. Compt. rend. soc, biol., **92**: 569–71, 1925. From Chem. Abst., **20**: 2505, August 10, 1926. Spring waters containing carbon dioxide and hydrogen carbonates have no amylolytic action, but strongly activate amylases of saliva and pancreatic juice. Effect is not due to alkali present, since solution of a hydrogen carbonate does not behave in like manner. Removal of carbon dioxide by boiling does not destroy activating effect. This excludes also possibility of biological action. Effect cannot be due to radioactivity nor to influence of pH, since latter is considerably changed on boiling.—*R. E. Thompson.*

Spring Waters Containing Hydrogen Carbonates and the Activity of Invertase from Beer Yeast. A. Mougeot and V. Aubertot. Compt. rend. soc. biol., **92:** 1504–6, 1925; cf. preceding abstract. From Chem. Abst., **20:** 2505, August 10, 1926. Effect of spring waters on invertase depends simply on pH.—*R. E. Thompson.*

Corrosion of Pipe Lines and Protective Coverings. F. R. McGrew. Petr. Devel. & Techn. in 1925, 521–5. From Chem. Absts., **20:** 2477, August 10, 1926. Only absolutely effective method of protection known is to encase in concrete; but it has several serious economic disadvantages. Highly encouraging results were obtained with Dearborn Chemical Company's "no-ox-id" compound, new pipe to which it has been applied showing no signs of corrosion after 3 years. Badly pitted pipe which was treated with "no-ox-id" showed no signs of further corrosion at bottom of pits. F. N. Speller. Ibid., 526–8. After considerable investigation, chrome iron (13–25 per cent chromium) was only material found to be non-corrodible to pronounced degree, but it costs about 60 cents per pound. Tests of pure iron, as uniform and homogeneous as could be made, did not show marked difference from less uniform materials, showing that problem is not one of homogeneity, but of keeping media which cause corrosion, and particularly that cause irregularity of corrosion, away from pipe. Remarkable anti-corrosion results in salt water have been obtained with open-hearth steel containing 1 per cent copper.—*R. E. Thompson.*

Chlorinated Potable Water and Its Applicability in Canning Vegetables. H. Serger. Z. Untersuch. Lebensm., **51:** 125–32. 1926. From Chem. Abst., **20:** 2546, August 10, 1926. Water which had been treated with chlorine in amounts ranging from 0.1 to 1 gram per cubic meter was found suitable for canning vegetables, quality of product being unaffected and tests for free chlorine negative.—*R. E. Thompson.*

Testing Progress of Chemical Reactions, etc. R. S. McNeil. U. S. 1,587,782, June 8. From Chem. Abst., **20:** 2552, August 10, 1926. Material undergoing treatment, e.g., water under treatment with zeolites, is passed through passage and there is added to material a substance, e.g., ammonium oxalate, sodium carbonate, or soap, which effects a restriction of passage upon occurrence of change for which test is to be thus made in the material, e.g., when compounds of calcium and magnesium, etc., have not been removed from the water and form a precipitate.—*R. E. Thompson.*

Waste Water of Dye Works. E. T. Ellis. Dyer & Calico Printer, **55:** 32–3, 1926. From Chem. Abst., **20:** 2585, August 10, 1926. Purification of the water and recovery of values contained.—*R. E. Thompson.*

Recovery of Furnace Dust, Treatment of Mine and Domestic Waste. W. M. von Bernewitz. Blast Furnace & Steel Plant, **14:** 21–2, 1926. From Chem. Abst., **20:** 2636, August 20, 1926. Application of thickeners to neutralization of mine water, and to water softening described.—*R. E. Thompson.*

Corrosion of Iron. W. G. WHITMAN. Chem. Rev., 2, 421–35, 1926. From Chem. Abst., **20**: 2648, August 20, 1926. Modern electrochemical theory of corrosion of iron is reviewed. Dissolved oxygen, pitting velocity, and effect of dissolved salts are discussed.—*R. E. Thompson.*

Protection of Iron Against Corrosion by Lead (the Galvanization of Iron by Lead). A. V. BLOM. Z. angew. Chem., **39**: 555–6, 1926. From Chem. Abst., **20**: 2648, August 20, 1926. Iron may be protected by painting with linseed oil suspension of lead pyrosol in lead oxide previously prepared in electric oven. Lead remains in surface of sheet iron after paint has been wiped off. Photographic plates show that lead pyrosol in lead oxide is effective while lead pyrosol in lead suboxide is without effect. Complete theory of mechanism is to follow in later paper.—*R. E. Thompson.*

A Method of Measuring Rates of Corrosion of Iron in the Presence of Carbon Dioxide and Air and the Influence of Electrical Potentials on Such Rates. A. HAYES, E. L. HENDERSON, C. E. STANEART and G. H. BRODIE. Proc. Iowa Acad. Sci., **31**: 280–1, 1924. From Chem. Abst., **20**: 2648, August 20, 1926. Cylindrical samples of wrought iron were subjected to action of water saturated with gas mixture. Four per cent carbon dioxide mixed with air dissolves 1 gram of iron per sq. cm. of exposed surface in 735 days, while it requires 1927 days with air alone. Fall of 0.25 millivolt per cubic centimeter increased rate of corrosion 28 per cent, but 0.025 millivolt had no appreciable effect. Methods of eliminating corrosion of this type given.—*R. E. Thompson.*

Method of Reducing the Corrosion of Water Conduits Consisting of Pipes of Two Different Metals. H. CASSEL. Korrosion u. Metallschutz, **1**: 75, 1925. From Chem. Abst., **20**: 2649, August 20, 1926. Considerable corrosion takes place at copper-iron joints in water conduits. This may be greatly reduced by inserting short length of lead piping between copper and iron pipes. The lead piping becomes coated with thin layer of lead oxide and acts as inert substance and, on account of separation of iron and copper and the poor conductivity of ordinary water, no current flows between the two metals; hence, corrosion is slight.—*R. E. Thompson.*

The Rusting of Iron. VI. A. KISTYAKOVSKII. Z. Elektrochem., **31**: 625–31, 1925. From Chem. Abst., **20**: 2647, August 20, 1926. First stage in rusting of iron is formation of thin oxide film, which corresponds to passive state and can be intensified by contact with oxidizing solutions. Further rusting occurs when film is broken. Five general states of iron surface can be determined, with different potentials. Relative specific volume of metal and oxide determines its adherence. Presence of electrolytes like carbon dioxide accelerate removal of protective oxide film.—*R. E. Thompson.*

McCulloch's Observations Regarding the Rapid Corrosion of Metals by Acids Within Capillaries. U. R. EVANS. J. Am. Chem. Soc., **48**: 1601–3, 1926; cf. C. A., **19**: 3471 and following abstract. From Chem. Abst., **20**: 2648, August

20, 1926. Localized corrosion of steel beneath rubber bands when exposed to 1.4 N. hydrochloric acid is found to occur only in presence of oxygen and hence is differential aëration effect. From same cause the center of an iron rod is dissolved, leaving a shell.—*R. E. Thompson.*

The Rapid Corrosion of Metals by Acids Within Capillaries. LEON MCCULLOCH. J. Am. Chem. Soc., **48:** 1603–4, 1926; cf. C. A., **19:** 3471. From Chem. Abst., **20:** 2648, August 20, 1926. Reply to EVANS (preceding abstract). Iron rivets wrapped with rubber bands showed at times 50 per cent more corrosion in air-free 1.4 N. hydrochloric acid than in air-saturated acid. Capillary pitting was noticeable in both cases but more distinct in presence of air.—*R. E. Thompson.*

Investigation of the Effect of Differential Aeration on Corrosion by Means of Electrode Potential Measurements. A. L. MCAULAY and F. P. BOWDEN. J. Chem. Soc., **127:** 2605–10, 1925. From Chem. Abst., **20:** 2648, August 20, 1926. Data on e.m.f. of zinc and iron surfaces. Potential differences are characteristic of differential aëration and differ with amount of corrosion which has occurred.—*R. E. Thompson.*

Porosity and Intensive Corrosion. Experiments on Commercial Sheet Zinc and Other Materials. U. R. EVANS. J. Soc. Chem. Ind., **45:** 37–44T; Bull. Am. Zinc Inst., **9:** 22–7, 32–7, 40, 55, 1926. From Chem. Abst., **20:** 2648, August 20, 1926. Pitting or localized corrosion of zinc in sodium chloride, magnesium sulfate and potassium sulfate was noted. Conclusion: Point corrosion follows and is due to capillary channels in original metal whether rolled or cast. Similar conclusion drawn for iron.—*R. E. Thompson.*

The Influence of Segregation on the Corrosion of Boiler Tubes and Superheaters. G. R. WOODVINE and A. L. ROBERTS. Iron and Steel Inst., 1926 (advance proof), 4 pp; Engineering, **121:** 646–7. From Chem. Abst., **20:** 2649, August 20, 1926. Boiler tubes are usually made from non-piping steel, and in most instances show segregation. Billets of such steel often split in piercing. Tubes showing segregation corroded severely during one year's service, while homogeneous tubes corroded very little under same conditions. Tubes of specially made steel free from segregation have shown better corrosion resistance in practice than ordinary tubes.—*R. E. Thompson.*

The Problem of the Origin of Punctiform Corrosion Phenomena. ERIK-LIEBREICH. Korrosion u. Metallschutz, **1:** 67–9; Chem. Zentr. 1925, II, 2024. From Chem. Abst., **20:** 2649, August 20, 1926. According to MCKAY the appearance of punctiform corrosion in iron pipes is related to potential difference arising from differences in concentration of solution in pipes. Since products of corrosion are alkaline, this theory must be rejected. It is more likely that break in uniform coating of rust inside pipe is caused by impurities or by chlorides. Since hydrogen set free by oxidation of iron is occluded by rust, a galvanic element hydrogen | liquid | iron is formed, which causes fur-

ther corrosion at particular location and consequent local cavities.—*R. E. Thompson.*

The Utilization of Rustless Steel in Hydraulic Installations. Krupp. Monatsh., **7**: 85. 1926. From Chem. Abst., **20**: 2647, August 20, 1926.—*R. E. Thompson.*

Consumption of Soap in Cleaning the Human Body in Water Containing Waste Liquor from the Potash Manufacture. J. H. VOGEL. Kali, **20**: 166–73, 1926. From Chem. Abst., **20**: 2713, August 20, 1926. Amounts of hardness precipitated by washing hands in tap water with and without additions of waste liquor were determined. Only small amount of hardness is precipitated with ordinary amount of soap; complete precipitation of total hardness does not take place on increased use of soap; precipitated amount is practically independent of amount of hardness present; precipitated hardness is mainly that of lime, average ratio of original lime-magnesia hardness being 100:103 and of the precipitated only 100:21. Suggested that precipitated magnesia hardness in experiments with addition of waste liquor originates both from natural and supplied excess. TJADEN'S calculation of increased soap consumption because of increased hardness from potash waste liquor thus appears erroneous.—*R. E. Thompson.*

Influence of Industrial Waste Waters on Rivers with Special Reference to the Schunter. VON MORGENSTERN. Centr. Zuckerind., **34**: 278–9, 1926. From Chem. Abst., **20**: 2713, August 20, 1926. The Schunter receives wastes from brown-coal mine, potash works, and sugar mill. First is characterized by high content of ferrous iron and sulfate, second by high chlorides and magnesia and third by organic matter. In December, 1924, many fish died and a nuisance was created. This was definitely traced to poisonous effect of magnesium chloride in potash wastes.—*R. E. Thompson.*

Ammonia-Chlorine Disinfection Process. W. OLSZEWSKI. Pharm. Zentralhalle, **67**: 312–3, 1926. From Chem. Abst., **20**: 2713, August 20, 1926. Process developed by RACE in 1917–18 involving use of gaseous ammonia and chlorine has been studied in its application to swimming pools and found to possess twice the disinfecting power of chlorine alone.—*R. E. Thompson.*

Radioactivity and Chemical Composition of Mineral Waters of the Hammam (Baths) of the Ouled Ali. POUGET and CHOUCHAK. Compt. rend., **182**: 1480–1, 1926; cf. C. A., **20**: 702. From Chem. Abst., **20**: 2784, September 10, 1926. One spring gave 28.2 millimicrocuries of Rn; the other, 5.4. Chemically they contain principally carbonates, calcium, and sulfates. These "eminently curative" waters, with temperatures of 44.5° and 52.0°, are used almost exclusively by natives.—*R. E. Thompson.*

Determination of Sodium; Several Applications. L. BARTHE and E. DUFILHO. Compt. rend., **182**: 1470–3, 1926. From Chem. Abst., **20**: 2802, September 10, 1926. Method of BLANCHETIÈRE (C. A., **17**: 3006) is very suitable

for determination of sodium in mineral water. Organic matter should be destroyed before applying test and phosphoric acid removed by precipitation as uranyl salt.—*R. E. Thompson.*

The Sinter of the Salt Baths of Nauheim. FRITZ ENSSLIN. Ber. Oberhess. Ges. Natur- u. Heilkunde, Giessen, **10:** 13 pp., 1925; Chem. Zentr., 1926, I, 1523. From Chem. Abst., **20:** 2806, September 10, 1926. Probable origin of salt water of springs discussed. Study of deposit of components present in the sinter showed that there is partial loss of carbon dioxide, oxidation of ferrous iron by atmospheric oxygen, and deposition of ferric hydroxide. With the latter is precipitated the greater part of the arsenic, phosphate, and alumina, after which are deposited carbonates of lead, zinc, calcium, and manganese and finally calcium sulfate. Silica remains relatively long in solution. Subsequently there is further deposition of zinc carbonate with appearance of zinc bicarbonate in the water.—*R. E. Thompson.*

The Hot Springs at Nasavusavu. C. H. WRIGHT. Analyst, **51:** 235–7. 1926. From Chem. Abst., **20:** 2806, September 10, 1926. Analysis of water in 1921 compared with analyses made in 1876, 1877–8, and 1879. Mineral matter consists chiefly of calcium chloride and sodium chloride, together with small quanities of magnesium, potassium, sulfate and silica.—*R. E. Thompson.*

Cause and Prevention of Embrittlement of Boiler Plate. S. W. PARR and F. G. STRAUB. Prov. Am. Soc. Testing Materials, 1926, No. 26 (preprint), 28 pp. From Chem. Abst., **20:** 2814, September 10, 1926. Embrittlement of boilers has occurred only when sodium carbonate is present in feed water either naturally or as result of treatment, and where only small amounts of sulfate are present. It occurs only in seams and rivets and is not related to quality of metal. Embrittlement cracks are characterized by following grain boundaries. Fatigue and corrosion cracks cut across the grain. Embrittlement has been duplicated in laboratory only by stressing steel above yield point in hot solutions of 35 per cent sodium hydroxide. In practice, embrittlement is prevented by adding sulfuric acid (or aluminium sulfate-magnesium sulfate with a settling tank) to feed water to make ratio sodium sulfate:sodium hydroxide over 2.—*R. E. Thompson.*

Metals to Resist Corrosion or High Temperatures. H. J. FRENCH. Trans. Am. Electrochem. Soc., **50** (preprint): 30 pp. 1926. From Chem. Abst., **20:** 2814, September 10, 1926. Discussion of some of principal characteristics and typical applications of metals used industrially to resist high temperatures or corrosion. Those considered include commercially pure copper, aluminum, lead, tin, silver, nickel, and iron and alloys in which these are predominating elements. Report is primarily résumé of previously published but widely scattered information, and somewhat more emphasis is placed upon industrial applications than on laboratory test data.—*R. E. Thompson.*

Corrosion-Resistive Metals. C. E. SHOLES. Textile Colorist, **48:** 264, 1926. From Chem. Abst., **20:** 2814, September 10, 1926. Manganese bronze recommended for chlorine bleaching.—*R. E. Thompson.*

Filtering and Purifying Water. C. H. PERRY. U. S. 1,590,120, June 22. From Chem. Abst., **20:** 3054, September 20, 1926. Mechanical features.—*R. E. Thompson.*

Potable Water in the Rural Localities of the Basso Reggiano. CARMELO BELLINI. Staz. sper. agrar. ital., **58:** 5–13, 1925. From Chem. Abst., **20:** 2886, September 10, 1926. Superficial, ordinary wells, which are frequently polluted, are being replaced by deep, tubular wells of iron pipe (8–10 cm. diameter). Peaty strata at even considerable depths give rise to ammonia, which passes into the water. Of 25 ordinary wells only one contained potable water, while of 12 tubular wells, only one contained non-potable water.—*R. E. Thompson.*

Remark Upon the Paper of G. Alsterberg "Method of the Determination of Elementary Oxygen Dissolved in Water in the Presence of Nitrous Acid." H. NOLL. Biochem. Z., **165:** 497–9, 1925; cf. C. A., **20:** 790. From Chem. Abst., **20:** 2887, September 10, 1926. Modification of method of WINKLER, as given by LEHMANN and NOLL (C. A., **12:** 964) serves well for determination of oxygen in presence of nitrites.—*R. E. Thompson.*

Magnesium Chloride and Magnesium Sulfate in the Daily Food. J. H. VOGEL. Kali, **20:** 181–4, 1926. From Chem. Abst., **20:** 2881, September 10, 1926. Discussion of potability of water containing magnesium chloride and sulfate originating from potash works' waste. Any household using commercial ocean salt is increasing "hardness" of meals with these same salts. From amounts of chloride found in human excretions it is assumed that daily consumption per adult averages 15 grams sodium chloride, containing 90 mgm. magnesium chloride and 123 mgm. magnesium sulfate. These amounts are far in excess of those ingested with water containing normal amounts of potash waste liquor, and have been consumed for centuries and proved harmless.—*R. E. Thompson.*

Oxidizability of Water as Measured by the Kubel-Tiemann Method and the Determination of the "Chlorine Number." K. KEISER. Gas- u. Wasserfach, **69:** 41–3 65–9 (1926). From Chem. Abst., **20:** 2887, September 10, 1926. Determination of oxidizability of water containing organic substances can generally be carried out by KUBEL'S permanganate method, or by chlorination method of FROBOESE (C. A., **15:** 913). If, however, humic substances or protein degradation products are present, chlorination method is the only accurate one, permanganate having no effect on these. Treatment of water with small amounts of chlorine, sufficient to destroy bacteria, does not affect oxidizability as measured by permanganate consumption. Efficiency of filtration process is increased and life of filter beds prolonged by preliminary chlorination of the water.—*R. E. Thompson.*

The Importance of the Chemical Composition for Judging Ground Water. J. HUG. Monats. Bull. Schweiz Ver. Gas- u. Wasserfachm., **5:** 1–4, 21–3, 41–6, 66–8; Chem. Zentr., 1925, II, 2222. From Chem., Abst. **20:** 2886, September 10,

1926. Subjects include Swiss regulations for drinking water, relation between ammonia content and geological nature of a water, between oxygen and salts, between hardness and infiltration zones, etc. Concluded that chemical analysis is capable of lending valuable information on internal condition and origin of water, which, together with geologic features, enables adequate judgment to be made.—*R. E. Thompson.*

The Red Lake at Witzenhausen on the Werra, a Natural Colloidal Water. E. WEDEKIND. B. d. Verein für Naturkunde zu Cassel 1925, 7 pp.; Chem. Zentr., 1925, II, 275. From Chem. Abst., **20:** 2887, September 10, 1926. Data given on this red-colored water, which behaves completely like a colloidal solution.—*R. E. Thompson.*

Alumina Cement. HANS EISENBECK. Chem.-Ztg., **50:** 165–7, 202–4, 239–41, 246–8, 1926. From Chem. Abst. **20:** 2902, September 10, 1926. Tests included tensile and compressive strengths of 1:3 standard sand mortar from 5 hours to 28 days; compressive strengths of mixes from 1:3 to 1:15 at various ages; bond strength between mortars made from various cements; exposure of portland and alumina cement mortars to solutions of various acids, bases, and salts; effect of frost action on strength and on temperatures in interior of specimens; compressive strengths of 1:3 mortars made with mixtures of portland and alumina cements.—*R. E. Thompson.*

Disposal of Beet-Sugar Waste Waters, With Reference to the Expected National Regulation of Waste Disposal. PRÜTZ. Deut. Zuckerind., **51:** 481–2, 513–5, 1926. From Chem. Abst., **20:** 2917, September 10, 1926. Possible methods for purification of battery and press wastes are: (1) Fermentation, either with or without precipitation of lactic acid by lime. This latter method absorbs proteins in precipitate and produces excellent fertilizer. Effluent is apt to be too acid for small streams, and should be sprayed on fields. Method is simple and generally applicable. (2) Chemical treatment with ferrous sulfate or alum and lime. This is expensive, requires accurate control and gives precipitate not suited for fertilizer use. (3) Purification by anaërobic bacteria. This is complete, but must be controlled, and produces much hydrogen sulfide. Effluent must be sprinkled on fields with deep drains. (4) Sprinkling alone. This is rarely successful, requires very large areas, and tends to produce algal growths in streams. Beet flume and washer waters usually require settling only. Sterilization of waste waters with chlorine before reuse in factory gives promise of being successful.—*R. E. Thompson.*

Determination of Iodine in Natural Waters. H. W. BRUBAKER, H. S. VAN BLARCOM and N. H. WALKER. J. Am. Chem. Soc., **48:** 1502–4, 1926. From Chem. Abst., **20:** 3053, September 20, 1926. Method used by HUNTER for determination of small amounts of I in thyroid was adapted to determination of iodine in water. Iodine is oxidized to iodate by boiling with sodium hypochlorite; acidified with phosphoric acid; potassium iodide added and iodine liberated titrated with sodium thiosulfate.—*R. E. Thompson.*

Clarification, Sterilization, and Filtration of Water Supplies, Trade Wastes, and Other Waters. Water and Water Eng., **28**: 185, 1926. From Chem. Abst., **20**: 3053, September 20, 1926. Clarifier, claristerilizer and clar filter have been designed by F. W. Brackett and Co. Ltd., for rapid, simple filtration. Filtration takes place by upward flow through two or more filters, area of each being increased and size of filtering material decreased at each stage of process. —*R. E. Thompson.*

Lactose-Fermenting Bacteria. FRED BERRY. Am. J. Pub. Health, **16**: 590, 1926. From Chem. Abst., **20**: 3053, September 20, 1926. Results of 640 samples show that bacteria which do not produce gas (10 per cent) in 48 hours in lactose broth are not significant.—*R. E. Thompson.*

Charleston Water Works Notes. J. E. GIBSON. Public Works, **58**: 294–5, 1927. A new 2 million gallon ellipsoidal bottom elevated tank, 80 feet in diameter, 35 feet high, and elevated 85 feet was put into service.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

Shepaug Tunnel, Waterbury Waterworks. GEORGE E. CLAPP. Public Works, **58**: 295–300, 1927. The construction of a new water tunnel about 7.5 miles long containing two 45 degree bends without sinking shafts is described. —*C. C. Ruchhoft* (*Courtesy Chem. Abst.*)

Modern Methods of Water Purification. C. ARTHUR BROWN. Water Works, **66**: 337–8, 1927. A short review of modern methods.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

Durham's New Water Works. D. M. WILLIAMS. Public Works, **58**: 197–203, 1927. A dam 80 feet high was built across the Flat River one mile above the pumping station forming an impounding reservoir of 547 acrea containing 4600 million gallons. This dam will ensure to Durham, N. C., an abundant supply of water at all times and the surplus water will be converted into power for pumping water to the filtration plant and other uses.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

Metering Services in Small Towns. CHARLES ADE. Water Works, **66**: 303–4, 1927. A discussion of the water waste problem and the economics of universal metering as applied to small towns.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

A New 300 m.g.d. Pumping Station in Chicago. ANON. Water Works, **66**: 215–21, 1927. The water is obtained from the Edward F. Dunne Crib and carried by the southwest lake and land tunnel by gravity to the pumping station. Four centrifugal pumps designed to deliver 300 m.g.d. against a head of 150 feet are driven by compound steam turbines. Power is developed in boilers fired by forced draft underfeed stokers. The discharge system, boiler room, auxiliary equipment, and building are described.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

How the Chicago Water System Grew. Anon. Water Works, **66**: 209–14, 1927. The first municipal system was constructed in 1852 and consisted of an 8 million gallon per day pumping engine, a 30-inch wooden intake to the suction well in the lake, 30 miles of cast iron pipe and 3 elevated wrought iron reservoirs of ½ million capacity each. The first intake tunnel 2 miles long was completed in 1867 and marked the beginning of the present system which has grown at a phenomenal rate and now includes six intake cribs, 70 miles of tunnels, 11 pumping stations, and 3,400 miles of cast iron mains. The present supply is not a first class one as measured by present standards because considerable pollution enters the lake at several sources in the Calumet region and chlorination is the only treatment used. Filtration is being seriously considered and an experimental filtration plant is under construction.—*C. C. Ruchhoft* (*Courtesy Chem. Abst.*).

Colorimeter for Precise Matching of Solutions in Nessler Tubes. JOHN H. YOE. Ind. Eng. Chem., **19**: 1131, October 1927. A new colorimeter has been developed, a detailed description being given.—*Edward L. Hopkins.*

Comparison of Commercial Chemical Limes. J. S. ROGERS. Ind. Eng. Chem., **19**: 1157–9, October, 1927. A survey of the various commercial limes was undertaken as a basis for the writing of specifications. The methods used in analysis, a table of analytical results and certain limits of impurities are given. Limits for SiO_2 and Al are set at 1 per cent and for Fe at 0.5 per cent. —*Edward S. Hopkins.*

Water Softening as Practiced at Oberlin Ohio. W. H. CHAPIN. Ind. Eng. Chem., **19**: 1182–7, October, 1927. At this softening plant after-precipitation of carbonates has caused clogging of mains after twenty years of operation. Monocarbonate alkalinity is always present and figures frequently indicated caustic alkalinity also. The precipitation trouble was eliminated by 30 days storage in reservoir after softening with lime whereby excess carbonates are precipitated. This plan has made subsequent filtration unnecessary. A very elementary description of the process and chemical reactions involved is given. —*Edward S. Hopkins.*

Water Softening at Springfield, Ill. CHAS. H. SPAULDING. American City, **36**: 4, 472–474, April, 1927. A description of the new softening plant consisting of two mechanical agitators, providing 42 minute mixing period at average circular flow of 0.8 feet per second, two Dorr clarifiers in parallel, with a detention period of 1½ hours, settling basins with 4-hour detention period, carbonating chambers with a 30-minute period and rapid sand filter units. Lime is unloaded and conveyed by a vacuum conveyor to bins from which it falls by gravity to the slackers and wet feed equipment. The cost of treating the water is $16.22 per million gallons exclusive of fixed charges.—*Chas. R. Cox.*

What Is Sound Water-Works Financing? CALEB MILLS SAVILLE. American City, **37**: 1, 41–44, July, 1927. A detailed discussion of rates, valuation, income, costs, and reserve funds pertaining to water works.—*Chas. R. Cox.*

Wallingford Water Supply and Pine River Filtration Plant. WM. A. MACKENZIE. American City, **36**: 3, 347–350, March, 1927. A new two million gallon per day rapid sand filtration plant was placed in use recently at Wallingford, Conn. Raw water is aërated, coagulated with alum, settled, filtered, and chlorinated. Only two of the designed four filter units were built at a cost of $36,000. Complete plant to cost $43,000.—*Chas. R. Cox.*

Sterilization of Municipal Water Supply of Horton, Kan., by Ultra-Violet Ray. N. T. VEATCH, Jr., American City, **36**: 3, 306–308, March, 1927. A brief description of the ultra-violet ray sterilization unit at the rapid sand filtration plant of Horton, Kan. The raw water is of low turbidity and the filters are efficient. Conditions therefore suitable for this rather rare form of water sterilization. The filtered water is of satisfactory quality, therefore the tabulated data do not permit estimation of effectiveness of final treatment under more adverse conditions.—*Chas. R. Cox.*

Fire Protection Factors Affecting the Insurance Rating of a Community. LAWRENCE DAY. American City, **36**: 1, 53–57, January, 1927. A discussion of the factors used in deriving the "base rate" for fire insurance in municipalities, namely, water supply, fire department, fire-alarm system, police department, building laws, hazards, structural conditions, and climatic conditions. Water supply is considered of more importance than the fire department, judging from the relative "points" allowed in the scoring system, namely, 1700 against 1500.—*Chas. R. Cox.*

Recent Improvements in the Water Supply of Nyack, N. Y. NICHOLAS S. HILL, Jr., American City, **36**: 6, 776–782, June, 1927. A detailed description of an interesting rapid sand filtration plant of 1.5 m.g.d. normal capacity recently built to replace slow sand filters. The coagulation basins are equipped with "ridge and valley" constructed floor. One-inch orifices, located in the valleys and spaced 2 feet apart, discharge sludge into 6-inch vitrified pipes spaced 3 feet apart and discharging into a collecting pipe fitted with gate valves. The strainer system consists of half-round cast iron pipes 6 inches in diameter and placed 9 inches center to center on cast iron spacers, which provide a continuous one-half inch opening on both sides. The four filter units are on one side of the pipe gallery, thus providing natural lighting of the gallery and simplicity of construction.—*Chas. R. Cox.*

Some Unusual Operating Features of Centralia's Filtration Plant. R. S. RANKIN. American City, **36**: 2, 172–175, February, 1927. The rapid sand filtration plant of Centralia, Ill., was placed in operation in 1926. Mud turtles greatly reduced the low-lift pump capacity until the intake screen was repaired. Red water trouble, unusual in Illinois, developed in the summer of 1926. The large impounding reservoir was drawn upon very heavily in 1925 and heavy growth of vegetation occurred on large uncovered area. Decay of this vegetation led to excessive content of carbon dioxide. The aërators remove most of this gas, but lime treatment also had to be practiced.—*Chas. R. Cox.*

Water-Works Pumping Equipment of Omaha's Metropolitan Utilities District. American City, 36: 2, 201–202, February, 1927. Description of largest horsepower centrifugal pumping unit for water works service, and the various water-wheel driven auxiliary equipment.—*Chas. R. Cox.*

New Combined Light and Water Plant of Martins Ferry, Ohio. CLAYTON DE VAULT. American City, 36: 2, 213–215, February, 1927. A description of new sources of water supply, consisting of 5 Layne wells, and of the new boiler and generator plant recently installed.—*Chas. R. Cox.*

The Modern Filtration Plant at Goldsboro, N. C. W. C. TOLER. American City, 36: 4, 471–472, April, 1927. A description of the new rapid sand filtration plant of 3,750,000 g.p.d. designed capacity.—*Chas. R. Cox.*

Water-Works Development in Palm Beach and West Palm Beach, Fla. MALCOLM PIRNIE. American City, 36: 6, 737–744, June, 1927. Historical sketch of water supply system of Palm Beach with brief description of new rapid sand filtration plant and construction details.—*Chas. R. Cox.*

Study and Extension of the Distribution Systems of Water-Works. LAWRENCE C. HOUGH. American City, 36: 5, 606–609, May, 1927. A plea for careful planning of distribution systems to economically serve the future population.—*Chas. R. Cox.*

A Pressure Filter Plant for a City of Three Thousand. American City, 36: 5, 621–622, May, 1927. A brief description of a pressure filter plant recently installed at Superior, Nebraska.—*Chas. R. Cox.*

The Electrically Operated Pumping Station, Kansas City, Mo. E. W. HARVEY. American City, 36: 6, 794–796, June, 1927. A description of the electrical equipment at three new motor-driven, centrifugal pumping stations.—*Chas. R. Cox.*

The New Water-Supply System of Ridgewood, N. J. E. J. FORT. American City, 36: 6, 816–820, June, 1927. Description of new deep well supply, where motor-driven, centrifugal, deep well pumps are utilized in 5 new wells.—*Chas. R. Cox.*

Proposed Water-Supply Improvements at Westfield, Mass., Involve Large Earth Dam. C. A. FARWELL. American City, 36: 6, 821–824, June, 1927. Details of a proposed earth dam 80 feet high to impound 500 million gallons of water.—*Chas. R. Cox.*

The Water-Supply and the City Limits. LOUIS BROWNLOW. American City, 37: 1, 27, July, 1927. A note upon the value of sanitary or water districts, embracing suburban areas, in solving the vexing problem of water supply for areas immediately outside incorporated municipalities.—*Chas. R. Cox.*

Control of Algae Growths in Outdoor Swimming Pools. CHESTER COHEN. American City, 37: 2, 167–168, August, 1927. $CuSO_4$ in ordinary doses was unsuccessful in controlling algae in outdoor swimming pool. As chlorine was applied daily for disinfection purposes in amounts sufficient to maintain 0.3 p.p.m. excess, the dose was increased to 0.6 p.p.m. with very satisfactory results. Before the pool was used next morning the excess chlorine had disappeared. The dose was again increased two weeks later when a regrowth of algae occurred.—*Chas. R. Cox.*

NEW BOOKS

Water Supply. By DR. ADOLPH HEILMANN. 211 pages, 66 cuts, 1927. A. Ziemsen, publisher. A volume on the scientific and technical principles of water supply by the director of the water works of the City of Dresden, Germany. The author discusses the collection and distribution of water in all of its aspects. The book is systematically arranged and contains a number of interesting examples and methods of attack on the general problem. A bibliography of a helpful nature is included. Like most books prepared abroad, it contains relatively little of modern American practice. The material is helpful, however, for those readers who are interested in comparing foreign procedure and practices with those in America.

Water-Works Pumping Equipment of Omaha's Metropolitan Utilities District. American City, 36: 2, 201–202, February, 1927. Description of largest horsepower centrifugal pumping unit for water works service, and the various water-wheel driven auxiliary equipment.—*Chas. R. Cox.*

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The Modern Filtration Plant at Goldsboro, N. C. W. C. TOLER. American City, 36: 4, 471–472, April, 1927. A description of the new rapid sand filtration plant of 3,750,000 g.p.d. designed capacity.—*Chas. R. Cox.*

Water-Works Development in Palm Beach and West Palm Beach, Fla. MALCOLM PIRNIE. American City, 36: 6, 737–744, June, 1927. Historical sketch of water supply system of Palm Beach with brief description of new rapid sand filtration plant and construction details.—*Chas. R. Cox.*

Study and Extension of the Distribution Systems of Water-Works. LAWRENCE C. HOUGH. American City, 36: 5, 606–609, May, 1927. A plea for careful planning of distribution systems to economically serve the future population.—*Chas. R. Cox.*

A Pressure Filter Plant for a City of Three Thousand. American City, 36: 5, 621–622, May, 1927. A brief description of a pressure filter plant recently installed at Superior, Nebraska.—*Chas. R. Cox.*

The Electrically Operated Pumping Station, Kansas City, Mo. E. W. HARVEY. American City, 36: 6, 794–796, June, 1927. A description of the electrical equipment at three new motor-driven, centrifugal pumping stations.—*Chas. R. Cox.*

The New Water-Supply System of Ridgewood, N. J. E. J. FORT. American City, 36: 6, 816–820, June, 1927. Description of new deep well supply, where motor-driven, centrifugal, deep well pumps are utilized in 5 new wells.—*Chas. R. Cox.*

Proposed Water-Supply Improvements at Westfield, Mass., Involve Large Earth Dam. C. A. FARWELL. American City, 36: 6, 821–824, June, 1927. Details of a proposed earth dam 80 feet high to impound 500 million gallons of water.—*Chas. R. Cox.*

The Water-Supply and the City Limits. LOUIS BROWNLOW. American City, 37: 1, 27, July, 1927. A note upon the value of sanitary or water districts, embracing suburban areas, in solving the vexing problem of water supply for areas immediately outside incorporated municipalities.—*Chas. R. Cox.*

Control of Algae Growths in Outdoor Swimming Pools. CHESTER COHEN. American City, 37: 2, 167–168, August, 1927. $CuSO_4$ in ordinary doses was unsuccessful in controlling algae in outdoor swimming pool. As chlorine was applied daily for disinfection purposes in amounts sufficient to maintain 0.3 p.p.m. excess, the dose was increased to 0.6 p.p.m. with very satisfactory results. Before the pool was used next morning the excess chlorine had disappeared. The dose was again increased two weeks later when a regrowth of algae occurred.—*Chas. R. Cox.*

NEW BOOKS

Water Supply. By DR. ADOLPH HEILMANN. 211 pages, 66 cuts, 1927. A. Ziemsen, publisher. A volume on the scientific and technical principles of water supply by the director of the water works of the City of Dresden, Germany. The author discusses the collection and distribution of water in all of its aspects. The book is systematically arranged and contains a number of interesting examples and methods of attack on the general problem. A bibliography of a helpful nature is included. Like most books prepared abroad, it contains relatively little of modern American practice. The material is helpful, however, for those readers who are interested in comparing foreign procedure and practices with those in America.

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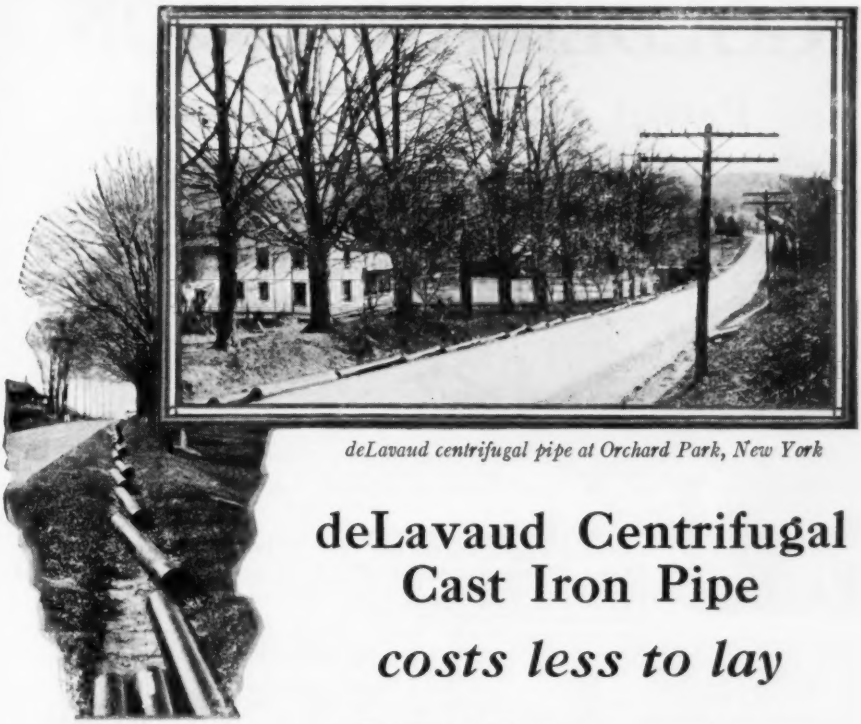

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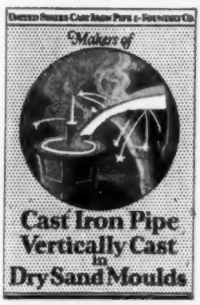

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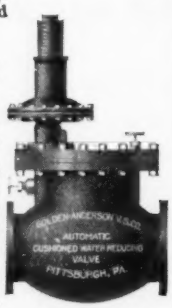

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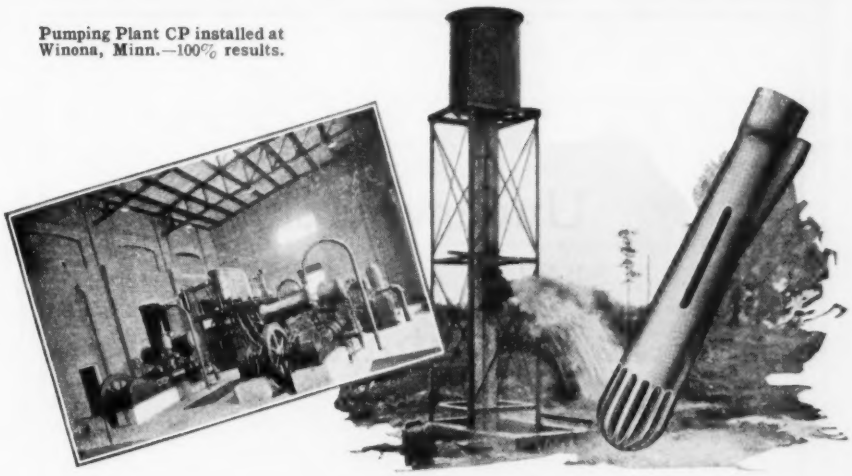

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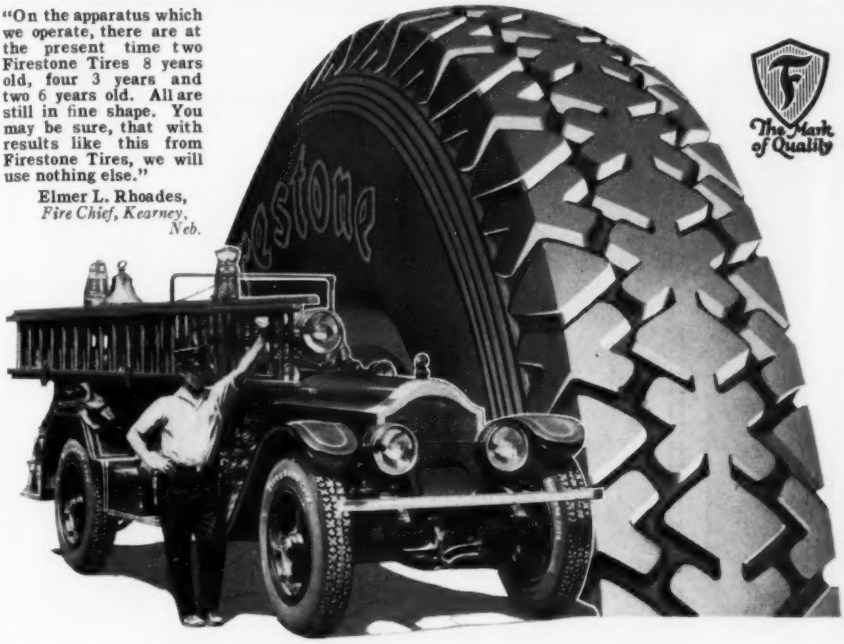

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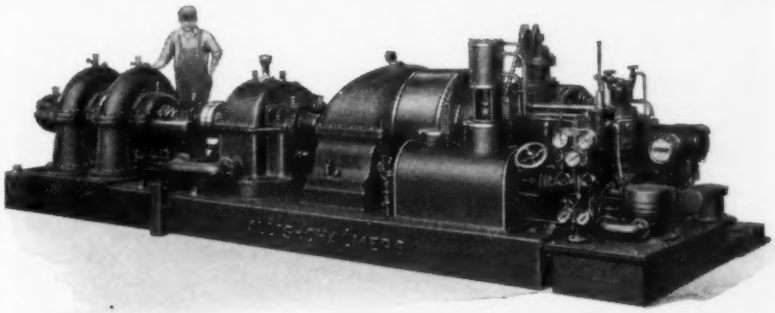

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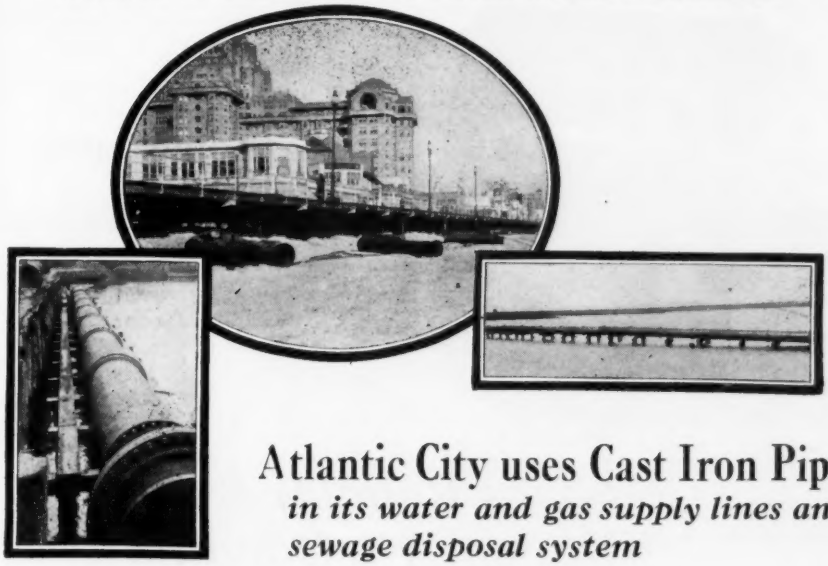
THE NICHOLS CHEMICAL CO., LTD., MONTREAL

CLEAN YOUR WATER MAINS

One does not have to be an expert mathematician to figure out that a clogged water main calls for a stronger pressure and that in turn calls for more coal—and literally burning up money. We can show you how to get dollar for dollar value out of every ton of coal. We can show you how to clean the water mains quickly and cheaply. Send us your address—that's all we ask of you.

National Water Main Cleaning Co.

CHURCH AND DEY STREETS
NEW YORK CITY



Atlantic City uses Cast Iron Pipe

in its water and gas supply lines and sewage disposal system

THESE illustrations demonstrate how well Cast Iron Pipe solves the problem of unusual installations.

The different lines run under sand, over salt marshes, on pontoons and across bridges.

Our engineering department will be glad to co-operate with you in the solution of any installation problem.

Makers of
deLavaud
Centrifugal
Cast Iron Pipe

We will have an exhibit at the Water-works Convention in Chicago, June 6th to 11th. We hope we will see you there.

United States Cast Iron Pipe and Foundry Company

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Philadelphia, Chicago, Birmingham, Buffalo, Cleveland, New York, San Francisco, Pittsburgh, Dallas, Kansas City, Minneapolis

Enslow Chlorine Comparator

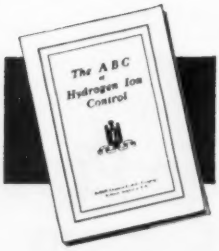
For determining free Chlorine in water, sewage and industrial wastes.

Gives Reliable Results Under All Conditions

The Enslow Chlorine Comparator embodies a new principle in that it is designed to eliminate not only the errors due to color and turbidity in the sample but also those due to the presence of manganese and iron.

It is therefore ideally suited for determining free chlorine in raw water, sewage and industrial wastes as well as in filtered water.

Full information gladly sent on request.



Write today for complimentary copy of "The A B C of Hydrogen Ion Control". It explains this valuable method in simple language and includes descriptions of all La Motte Equipment with detailed information on its use.

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424 Light St. Baltimore, Md., U. S. A.

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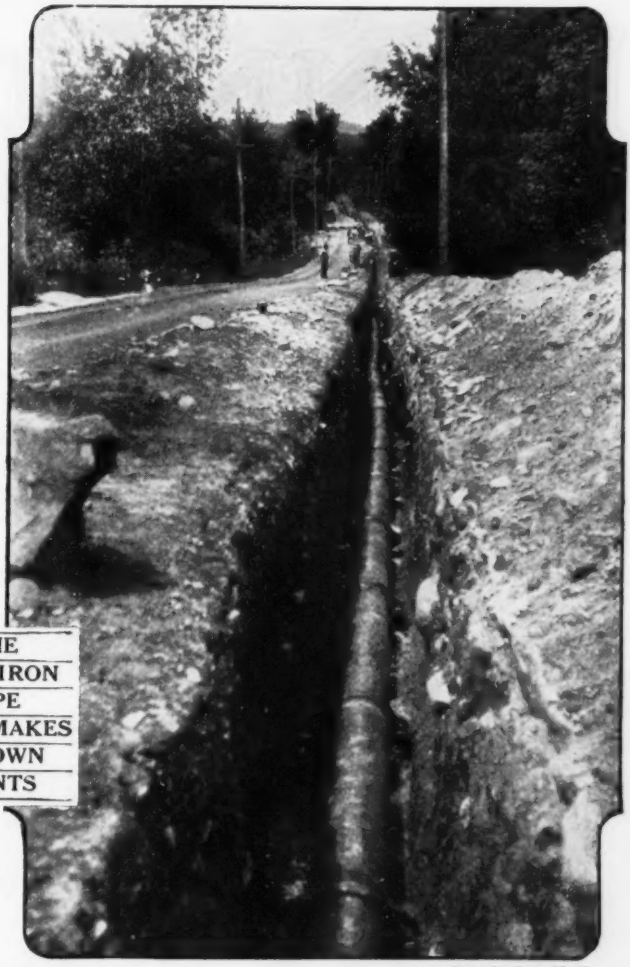
SERVICE BOXES
With *Stay-on* Covers
Just what you have been waiting for . . . Interchangeable with "Buffalo" boxes . . . .
Ask for Monitor Service Box catalog.



THE CAST IRON PIPE THAT MAKES ITS OWN JOINTS

East Jaffrey, N. H.

Here's dependable water supply for you!

Dependable because it's 100% cast iron. No hot lead, no cold lead, no lead substitutes, no pouring, no calking. Nothing to work loose, nothing to deteriorate in these flexible, dependable joints—machined iron-to-iron *joints as tight as the wall of the pipe itself.*

Wrenches the only tools. Address nearest office.

UNIVERSAL CAST IRON PIPE
No bell holes to dig! No joints to calk
THE CENTRAL FOUNDRY COMPANY
Subsidiary of The Universal Pipe and Radiator Company
Graybar Building, 420 Lexington Avenue
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KENNEDY

VALVES-PIPE FITTINGS-FIRE HYDRANTS

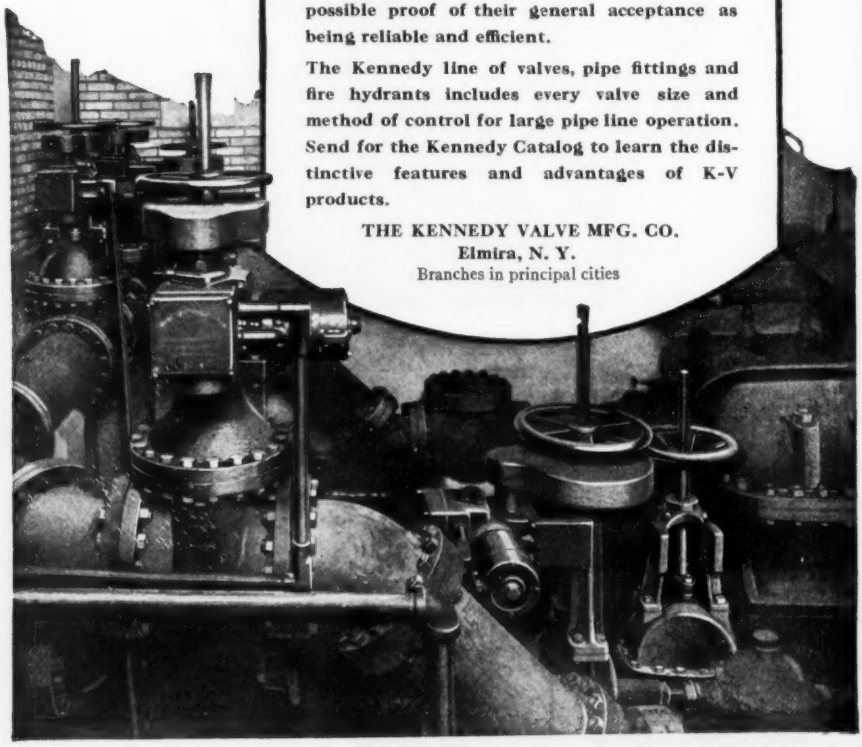
50th Anniversary 1877-1927

WATER supply and fire protection equipment *must* be thoroughly dependable. Only apparatus of the highest possible grade, meeting the most rigid requirements, can be used.

The wide use of Kennedy Valves and Fire Hydrants by villages, towns and cities throughout the country is therefore the strongest possible proof of their general acceptance as being reliable and efficient.

The Kennedy line of valves, pipe fittings and fire hydrants includes every valve size and method of control for large pipe line operation. Send for the Kennedy Catalog to learn the distinctive features and advantages of K-V products.

THE KENNEDY VALVE MFG. CO.
Elmira, N. Y.
Branches in principal cities



CEMENT LINED
SERVICE PIPE

Does not depend on water pressure to hold it in shape.

Is not injured by careless handling or back-filling.

Uses standard fittings.

Sixty years use proves it rustless.

Has no harmful effect on any water.

Now standard in dozens of the most progressive cities and towns.

Inexpensive.

CEMENT LINED PIPE CO.
LYNN, MASS.

The Ludlow Valve Mfg. Co.

MANUFACTURERS OF

Gate Valves
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Check and Foot Valves

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ALL SIZES—EVERY STYLE—ANY PRESSURE

Fire Hydrants

Simple in Construction

Efficient **Frost-Proof**

"All parts removable without digging up hydrant. Special device prevents street from being flooded should standpipe be broken. Minimum expense to install and maintain."

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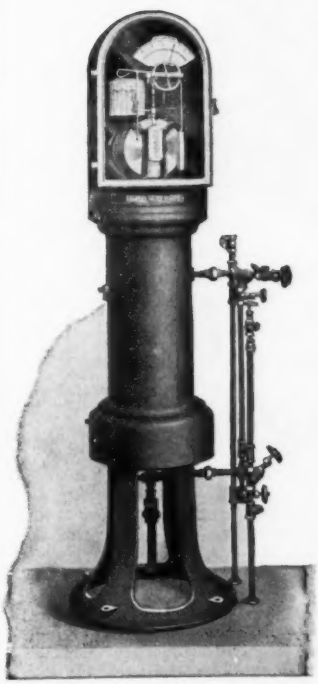
Is Your Water Works Pumping Station Operating Efficiently



Simplex Meter Register

Every up-to-date water works manager holds it essential to know at all times the efficiency of his plant. If pumping, he must know the fuel consumed and the amount of water pumped. Pump counters are unreliable, on account of pump slip varying from zero to 40% in reciprocating pumps, and on centrifugal pumps they are inoperative. If the supply is by gravity, he must know the quantity of water flowing.

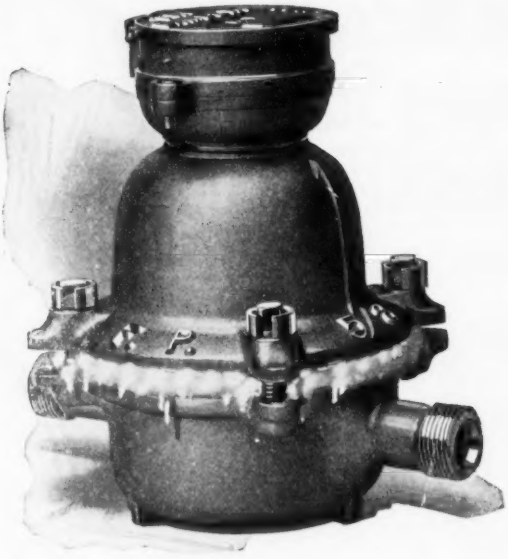
Simplex meters provide for either one of these conditions by giving a continuous record of the flow of water. It is simple, rugged, reliable and accurate from the maximum down to 5% of the maximum flow, without material loss of pressure.

Interesting data on the "Simplex Venturi Tube Meter" sent upon request

SIMPLEX VALVE AND METER CO.

Manufacturers of Meters for Water, Sewerage and other liquids, Rate Controllers, Automatic Air Valves, Regulating Valves, and Hydraulic Apparatus of Special Design

6759 UPLAND STREET **PHILADELPHIA, PA.**



FROZEN!—but not damaged

Here is an actual photograph of a LAMBERT Frost-Proof Meter which has been frozen to an extent that would put the ordinary meter completely out of commission.

This is made possible by a patented, non-corrosive yielding bolt device which allows the upper and lower casing, disc chamber and gear train to part without damaging the meter in any way. Five minutes' labor the only repair cost.

The expense and annoyance from frozen water meters can be eliminated for all time through the installation of the LAMBERT Frost-proof.

It has been proved that the LAMBERT is the easiest water meter to take apart and put together again as well as the simplest, most reliable and accurate.

If you are interested in other types of meters, we make one for every requirement.

THOMSON METER CORPORATION

SALES OFFICE, 50 E. 42nd STREET NEW YORK CITY, N. Y.

LAMBERT FROST PROOF METERS

"The Engineer was Particular—"

and here's what the Contractor had to say about him:

"—Our superintendent tells us that after the McWane pipe is laid and properly calked that he had no trouble in making tests.

" The Engineer was particular in testing. He would get down in the trench and examine each Precalked joint, and usually took a dry rag and passed it entirely around the joint, and if it showed the least moisture the joint would be recalked. Fortunately for us, he found very few joints that showed moisture."

We like a "fussy" engineer. He does good work himself, demands it in others, and appreciates it in McWane pipe.

He may be hard to convince at first that a lighter pipe can be stronger, a factory-made lead joint better than a trench-made one—

But when he does see it, he's a life convert to "3 times the speed for ½ the labor" (McWane Precalked Joint Pipe).

Sizes 1¼ thru 8 inches. Standard lengths.
Precalked Fittings

"We pioneered—and lead—in production of very small cast iron pipe."

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Successor To

NEW YORK CONTINENTAL JEWELL FILTRATION COMPANY

More Than 500 Municipal Filtration Plants Installed

GRAVITY FILTERS
PRESSURE FILTERS

FILTER EQUIPMENT OF EVERY DESCRIPTION

Dry Chemical Feeders	Control Tables
Wet Feed Apparatus	Effluent Controllers
Loss of Head Gauges	Rate of Flow Gauges
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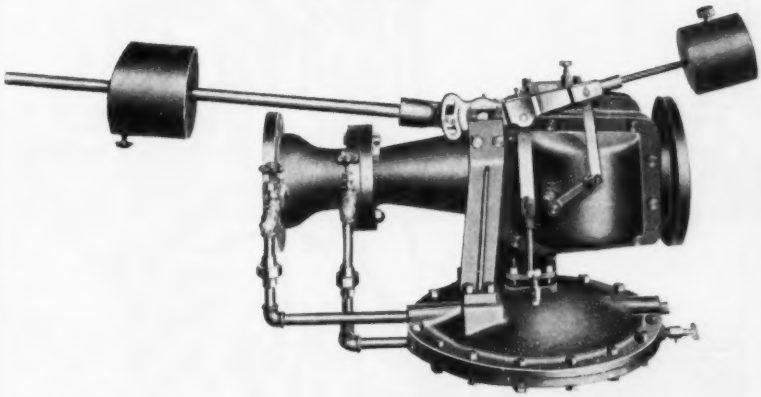
Fourth and Lehigh Avenues
PHILADELPHIA, PENNA.

ORIGINATORS OF MECHANICAL FILTRATION

VENTURI
"VENTURI" Registered



Install It and Forget It!

Whether you think about it or not the Venturi Direct-Acting Controller will be right on the job maintaining a constant rate of flow through the filter.

Dependable service of this kind counts, especially in the small and medium size plants where it is impractical to station highly skilled operators or where the operators have plenty to do without continually watching the filters.

Actual installations at various plants over a period of two years have proved so successful that this new Direct-Acting Controller is now offered as the simple, rugged, and powerful controller for which you have been waiting.

Write for New Bulletin 232

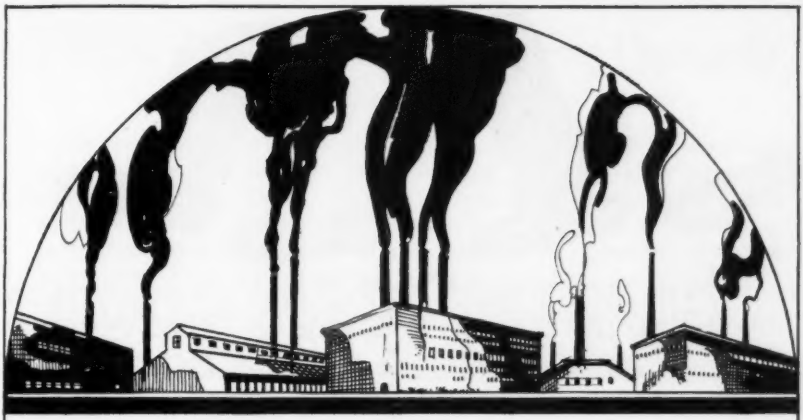
BUILDERS IRON FOUNDRY

"Builders of the Venturi for 36 Years"

9 Codding Street **Providence, R. I.**

The nation's strength is the nation's health. Buy Christmas Seals and help preserve it.

THE NATIONAL, STATE, AND LOCAL TUBERCULOSIS ASSOCIATIONS OF THE UNITED STATES



Decalso

(REG. U. S. PAT. OFF.)

The Reliable Zeolite

For Water Softening

More than ten years in continuous use in industrial and domestic installations.

AMERICAN ZEOLITE CORPORATION

New York
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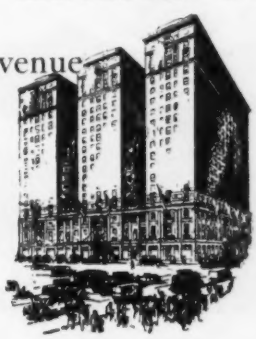

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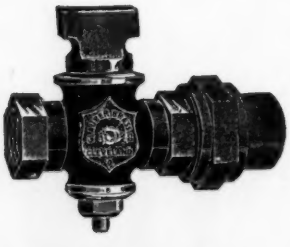
NEVER FAIL TO MAKE A GOOD IMPRESSION - ONE THAT LASTS

THE ONLY BRASS GOODS GUARANTEED 5 YEARS GLAUBER



GLAUBER BRASS MFG. CO.

Cleveland, Ohio

The A. P. Smith Manufacturing Company

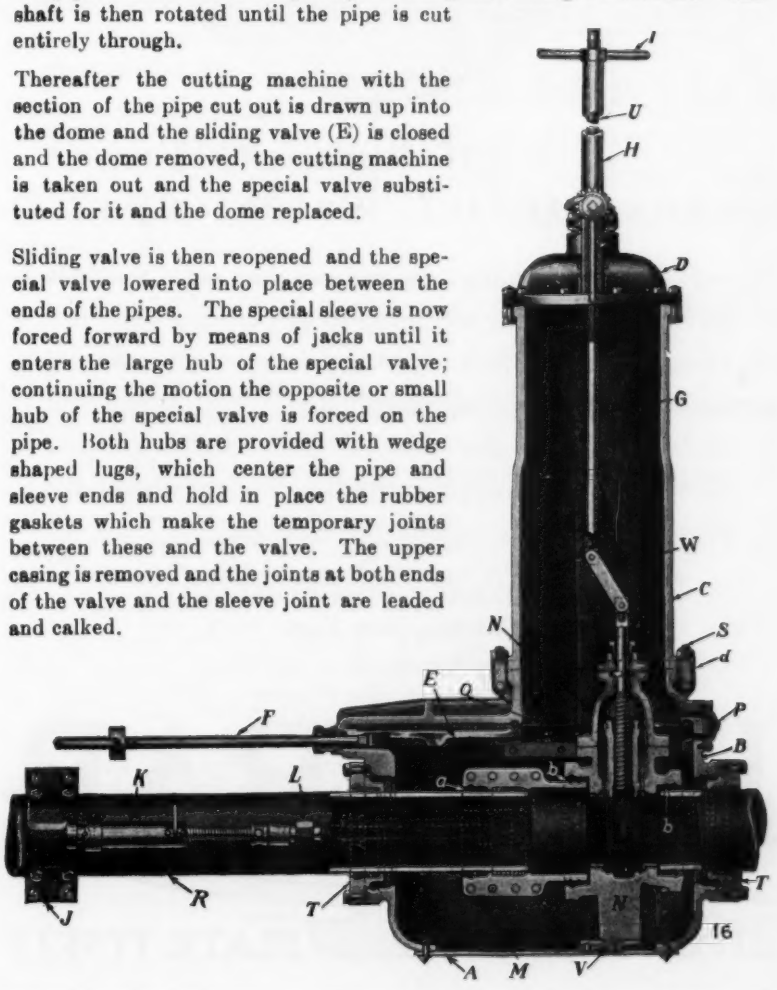
East Orange, New Jersey

Manufacturers of Water Works Specialties, one of these specialties shown herewith, namely a Machine for inserting 4″, 6″ and 8″ valves in existing straight lines of pipe under pressure. The machine is made in other sizes as follows: No. 2 for inserting 8″, 10″ and 12″ valves, No. 3 for inserting 14″, 16″, 18″ and 20″ valves, No. 4 for inserting 24″ horizontal valves and we are now designing a machine for inserting 30″ valves.

The pipe is cut about one-half through and the special sleeve is then bolted around the pipe, the end of the sleeve being placed within a fraction of an inch of the cutting tool; the Inserting Machine is then attached around the pipe and the sleeve completely enclosing the cutting mechanism. The shaft is then rotated until the pipe is cut entirely through.

Thereafter the cutting machine with the section of the pipe cut out is drawn up into the dome and the sliding valve (E) is closed and the dome removed, the cutting machine is taken out and the special valve substituted for it and the dome replaced.

Sliding valve is then reopened and the special valve lowered into place between the ends of the pipes. The special sleeve is now forced forward by means of jacks until it enters the large hub of the special valve; continuing the motion the opposite or small hub of the special valve is forced on the pipe. Both hubs are provided with wedge shaped lugs, which center the pipe and sleeve ends and hold in place the rubber gaskets which make the temporary joints between these and the valve. The upper casing is removed and the joints at both ends of the valve and the sleeve joint are leaded and calked.



A clear water-way means greater water capacity

It will be readily understood why LOCK BAR STEEL PIPE has so much more carrying capacity. Obstructions to flow, causing friction, and reducing capacity are practically eliminated. The absence of obstruction and the smooth inner surface further eliminate opportunity for the building up within the pipe of deposits to restrict the pipe area.

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7 Dey Street, New York, N. Y.

WESTERN STEEL PIPE COMPANY
444 Market Street, San Francisco, Cal.

LOCK-BAR

Before Closing

STRONG AS THE PLATE ITSELF

EDSON

DIAPHRAGM
PUMP SPECIALTIES

Hand and Power Outfits

LIGHT PORTABLE TRAILER PUMPS

HEAVY DUTY One or Two Pump UNITS
with 3-inch or 4-inch Suction

Insist on GENUINE EDSON Pumps, Suction Hose, Diaphragm with Bead, etc.

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EDSON MANUFACTURING CORP.
Main Office and Works
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Highest Purity Only
In "White Cap" Cylinders

CAUSTIC SODA

Solid and Flake

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CAST IRON PIPE
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IS MADE RIGHT

National Cast Iron Pipe Company
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BIRMINGHAM, ALABAMA

Manufacturers of Sand Cast and deLavaud
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PIPE

Also Fittings, Flange Pipe, Flange Fittings and Special Castings

We are featuring our 2′ Bell and Spigot Cast Iron Service Pipe in 6′ lengths with prepared joint. Write or wire us for information.

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Automatic Pressure Control Valves
Feed Water Filters
Portable Fire Hydrant Heads
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ESTABLISHED 1879

NICHOLAS ENGEL
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CAST IRON
WATER & GAS PIPES
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Special Castings, Fire Hydrants, Valves
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WOOLWORTH BUILDING 233 BROADWAY
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"Those Diamond Alkalies are carried in warehouse by distributors all over the country. In fact, there's a distributor of Diamond Alkalies right in this town. Your requisition is as good as delivered, so forget it."

"By the way Jim, I am dictating a letter to the Diamond Company for a carload of that Diamond 58% Soda Ash you said was so remarkably pure and uniform. Carloads, you know, are shipped direct from their plant at Painesville, Ohio."

Diamond Alkali Co.
Pittsburgh, Pa.
and everywhere!

ALKALI

UNION WATER METER CO.

Worcester, Mass.

Union Water Meter Company is one of the few American manufacturing concerns that has progressed sixty years under the same ownership. This pioneer company began in the early sixties and incorporated in 1868 the organization which has won a place of leadership in the manufacture of water meters, valves, stops, pipe lining equipment and fire whistles.

Catalog sent on request

New York Office: **50 Church St.**
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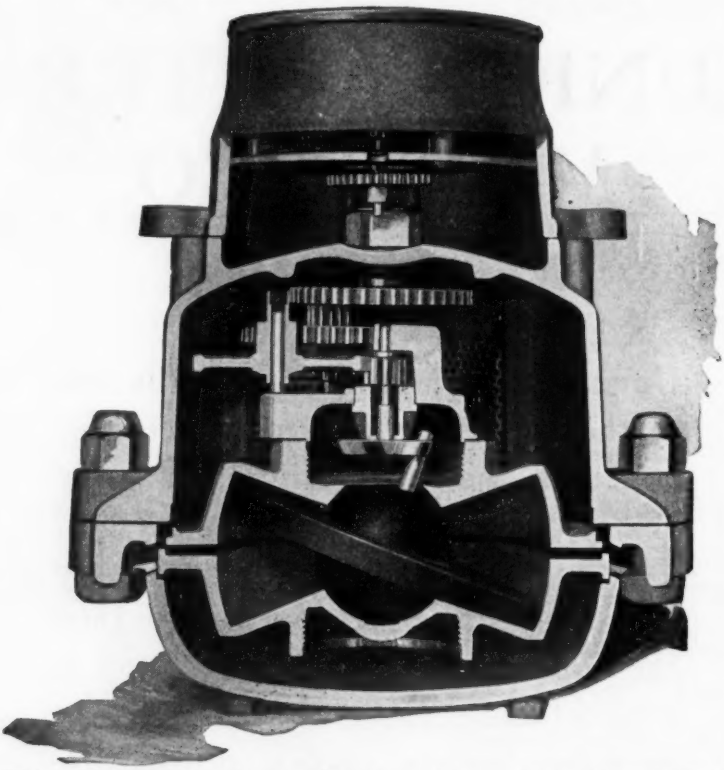
AMERICAN AND NIAGARA
WATER METERS
WITH BREAKABLE FROST BOTTOMS (Patd.)



This sectional view shows a $\frac{5}{8}$ inch or house size meter cut at right angles to the pipe line. The breakable frost bottom has been broken by a freeze up.

NOTE:

1. How the breakable section of the bottom is entirely inside and independent of the meter flange. This allows the six flange bolts to be drawn directly up on the gasket. Meter is tight on highest pressures.
2. How the breaking of the frost bottom immediately releases the measuring chamber. No warping.
3. How the submerged gears can remain fixed in the ice, while their bearing shafts move downward. No breakage.

These and other points described in large illustrated catalogue. Write for your copy.

Write for catalog and prices

BUFFALO METER CO.
2914 Main St. BUFFALO, N. Y.

Niagara and American meters comply in all respects as to accuracy and capacity with the Standard Specifications of the American Water Works Association

MATHIESON
Industrial
Chemicals

Chlorination—an Accurate Measure of Community Progress

MORE and more, the social and industrial progress of a city is accurately measured by the modern efficiency of its water works system.

Not only are up-to-date methods of water purification—as exemplified, for instance, by chlorination—directly responsible for community health and safety. They have a direct influence upon community prosperity, as well, because there is no better asset for any community than an ample supply of absolutely pure water.

Municipal officials and water works engineers have long recognized the importance of Mathieson Liquid Chlorine and Mathieson container equipment as important auxiliaries in the efficient sterilization of water supplies.

The Mathieson organization, as the world's largest shipper of Liquid Chlorine, offers a specialized service which includes special water works tank car equipment, expert traffic counsel, technical advice, together with a chain of emergency warehouse stocks throughout the country. This service is placed at your disposal the moment EAGLE-THISTLE Chlorine is specified

CAUSTIC SODA
LIQUID CHLORINE
BICARBONATE OF SODA
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Works: Niagara Falls, N.Y.—Saltville, Va. *Warehouse Stocks at all Distributing Centers*

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NASH
WATER METERS

A disc type, with every worth while modern improvement. All bronze construction. Large, extra slow-moving, balanced disc. Enclosed intermediate. Made either with or without frost protection feature, as required.

Send for fully descriptive booklet.

NATIONAL METER COMPANY
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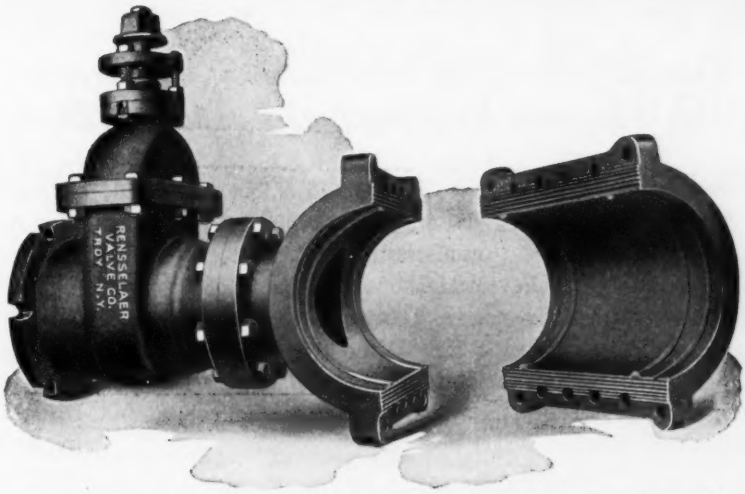
SAN FRANCISCO LOS ANGELES TORONTO, ONT.



SOME of the POINTS OF SUPERIORITY of RENSSELAER TAPPING SLEEVES

Require ***less lead*** *for Calking*
Easier to center *on pipe* ***before pouring***
Give ***Extra Pipe Protection***
Bolts require ***No Iron Washers***
Each Size *carefully* ***designed for its Working Pressure***
Can be used with all Standard Tapping Machines

Rensselaer Tapping Sleeves are the only Sleeves on the market which are built with two Raised Rings which are a part of the Sleeve Casting itself. These Rings are used as Stops for the Hemp or Jute against which the Lead is poured to make the joint. In other types of Sleeves, without Rings, the Lead, when poured, fills entire space up to point at which cut is made.

The Raised Rings also permit easier centering of Sleeves on Pipe, also permit revolving Sleeve on pipe making it easier to tighten nuts on bolts which connect the two halves of the Sleeve.

The Bolting Flanges on all Sizes of Rensselaer Sleeves are made the full length of the Sleeve, permitting a greater number of bolts to be used back of point calked, giving greater protection to pipe at point where piece is cut out. This is especially important as in some cuts a hole nearly one-half the size of pipe is cut away.

BOOK No. 11 GIVES FURTHER PARTICULARS

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PITTSBURGH, Oliver Bldg. NEW ENGLAND, C. L. Brown, Northboro, Mass.

Transactions of the International Conference on Sanitary Engineering, London, 1924

Distributed in the United States by the A. P. H. A.

THE CONTENTS cover a wide variety of subjects, including State Sanitary Administration; Works for the Prevention of Malaria and Yellow Fever; Methods of Disposal of Sewage and Trade Wastes in Various Countries; Treatment of Sludge Arising from the Agitation Processes of Sewage Disposal; Fertilizing Value of Sewage Sludge; Sewerage and the Control of Storm Water; Design of Sedimentation Works; House Sanitation; Refuse Collection and Disposal; National Control of Water Sources. *Price, $4.00*

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Definitions for Sewerage and Sewage Disposal Practice; Water Supply and Purification, Report of the Committee; Values in the Control of the Environment; Sewage Analysis and its Interpretations; Bathing Places, Report of the Committee; Incinerator Specifications and Contract Tests.

Clip the coupon below for an application blank for membership or a sample copy of the Journal or both.

The American Public Health Association,
370 Seventh Avenue, New York City.

I am interested in membership in the Association. Please send me an application blank....

I would appreciate a sample copy of the American Journal of Public Health.....

Name.....

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SEVENTEEN years ago Republic developed the first electrically operated flow meter. The flow meter which made remote control possible.

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Eliminated the effects of voltage variation in electrically actuated reading instruments.

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Republic flow meter accuracy has been proven by the experience of thousands of users. There are over 40,000 now in use in all parts of the world.

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5.

Republic developed the multiple recorder which will simultaneously record three or more records on one wide strip chart without confusion.

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Republic engineers, men of thorough engineering experience, are available in all industrial centers for the solution of boiler room problems.

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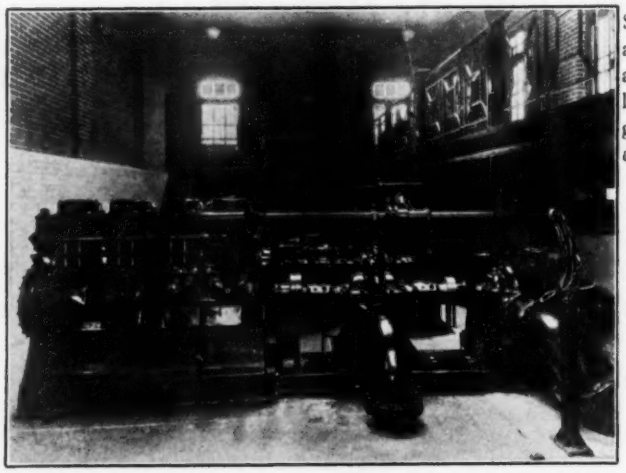
THE STANDBY UNIT IS IMPORTANT
IN EMERGENCY OPERATION IS IMPERATIVE



Sterling engines are accepted practice and over 500 installations are your guarantee that these engines are right.

Sterling
High Duty

Internal Combustion Engines

Belleville, Ont., 8 in. 3 stage DeLaval centrifugal driven by 8 cylinder 240 HP Sterling, furnished by Turbine Equipment Co., Toronto.

THE LOWEST COST STANDBY

STERLING ENGINE COMPANY Dept. C-3 **BUFFALO, N. Y., U. S. A.**
10 to 3000 H. P. for standby and peak load. 900–1200–1400 R. P. M.

SULPHATE OF ALUMINA

MANUFACTURED BY

THE JARECKI CHEMICAL CO.

CINCINNATI, OHIO

FOR FULL PARTICULARS APPLY TO

ISAAC WINKLER & BROTHER, Sole Agents
CINCINNATI, OHIO

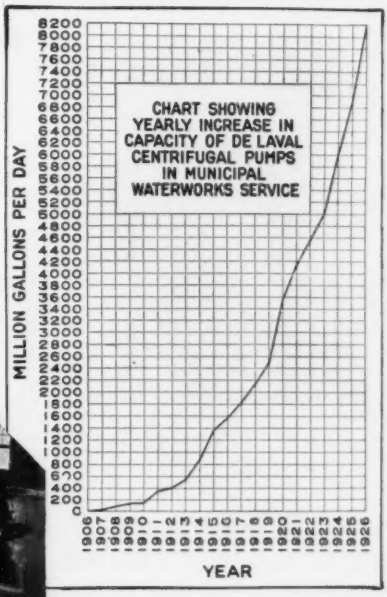
STEEL PIPE

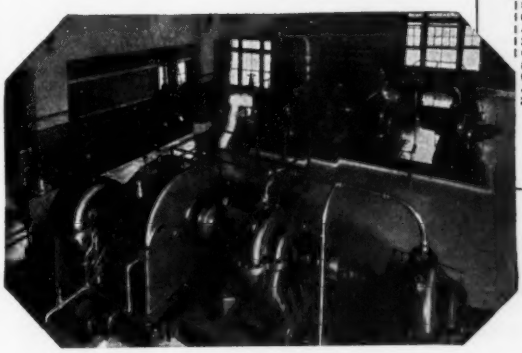
WE ARE PREPARED TO FURNISH AND INSTALL LONG-LIFE PRESSURE PIPE IN ANY QUANTITY AND IN ANY LOCALITY.

PENSTOCK CONSTRUCTION COMPANY
SHARON, PA.

New York **St. Louis** **Tulsa** **Houston**

15 Years Progress in Water Works Pumps





High head pumping station of the City of Tampa, Fla., containing three De Laval Geared Turbine Driven Centrifugal Pumps, two rated at 7000 gallons per min., and one at 3500 gallons per min., all against 200 ft. head. The low head station at Tampa also contains three De Laval Geared Turbine Driven Pumps, two of which are rated at 8700 gallons per min. each and one at 4500 gallons per min., all against 30 ft. head.

THE first De Laval Geared Turbine Driven Centrifugal Pump for municipal water works service was installed about 15 years years ago. Today, the aggregate capacity of De Laval Centrifugal Pumps in water works service exceeds 8,000,000,000 gallons per day, sufficient to supply nearly one-half of the population of the United States.

The reason for this tremendous growth is plain. Analysis and comparison of pumping costs, taking into account fixed charges as well as fuel consumption and attendance, has shown that the De Laval Centrifugal Pump delivers water at the lowest total cost. These pumps range in size from small units driven by electric motors or gasoline engines, up to units developing around 5000 HP., with duties exceeding 200,000,000 ft. lbs. per 1000 lbs. of steam.

We have numerous leaflets describing a great variety of water works pumping stations, and would be glad to send appropriate issues if you will state your conditions.

De Laval

Steam Turbine Co., Trenton, N.J.

LOCAL OFFICES: Atlanta, Boston, Charlotte, Chicago, Cleveland, Denver, Duluth, Havana, Helena, Honolulu, Houston, Indianapolis, Kansas City, Los Angeles, Montreal, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Salt Lake City, San Francisco, Seattle, St. Paul, Spokane, Toronto, Vancouver. 669

THE CLARK METER BOX

affords absolute protection from damage of any nature.

Perfect Lock

consists of one-piece phosphor bronze bolt engaging on an incline plane on cover to lock and likewise engages on a similar plane on lid to unlock. No rivets, bolts or screws, to rust, preventing operation.

The Only All Bronze Meter Box Lock.

H. W. CLARK COMPANY

Manufacturers of Water Works Equipment

MATTOON, ILLINOIS

Meter Boxes	Meter Coupling Yokes	Valve Boxes
Vitrified Box Bodies	Service Boxes	Valve Housings
Forms for Concrete Bodies	Repair Lids	Meter Testing Machines
Meter Couplings	Vise for Brass Pipe	Trouble Finding Instruments

DIFCO

DEHYDRATED MEDIA

Recommended by Standard Methods Committee for adoption in "Standard Methods of Water Analysis."

BACTO-NUTRIENT AGAR

For use in plate counts. Conforms to "Standard Methods 1925" in formula, ingredients and reaction.

LEVINE'S EOSINE METHYLENE BLUE AGAR

For colon-aerogenes differentiation. Prepared according to the requirements of "Standard Methods 1925."

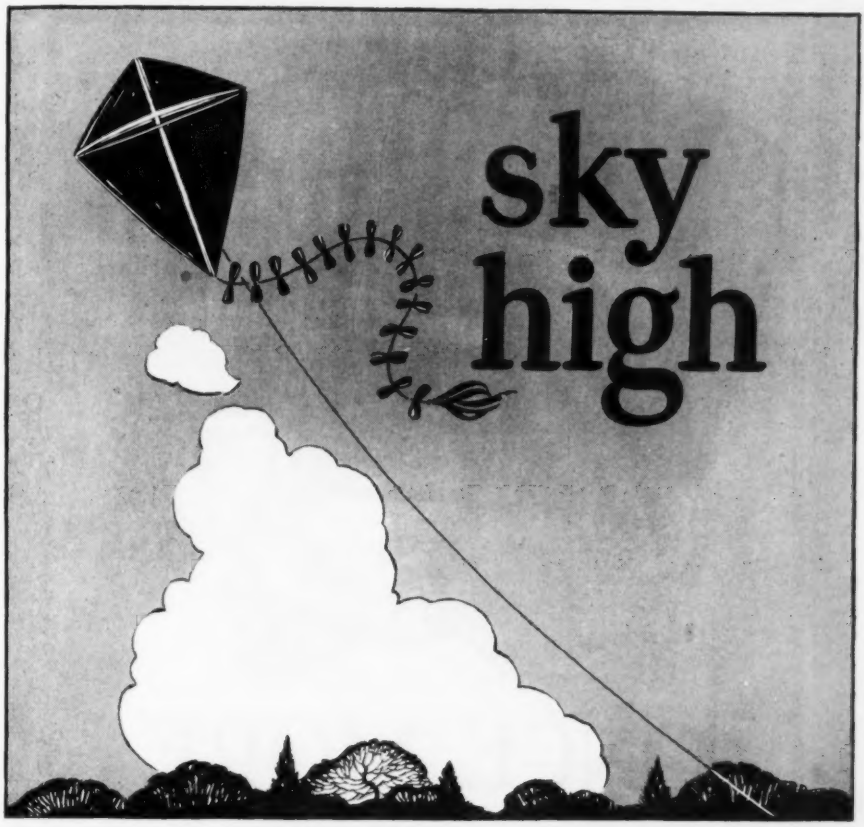
Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS

In the research and development of Bacto-Peptone and Dehydrated Culture Media

DIGESTIVE FERMENTS COMPANY

DETROIT, MICHIGAN, U. S. A.



Internal balance raises the Hersey Water Meter to an automatic revenue computor of the highest quality. No other meter has this feature.

HERSEY Water Meters will continue to be completely dipped-tinned in spite of the soaring price of tin. No other meter offers this protection against corrosion. . . a meter's worst enemy.

Hersey Manufacturing Company, South Boston, Mass.

HERSEY
WATER METERS

NEW YORK, N. Y., 290 Broadway
PORTLAND, OREGON, 475 Hoyt St.
PHILADELPHIA, Pa., 314 Commercial Trust Bldg.
ATLANTA, Ga., 510 Haas-Howell Bldg.
DALLAS, TEX., 2301 Griffin Street
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Main Office and Works: Corner E and 2nd Sts., South Boston, Mass.

ONCE MORE

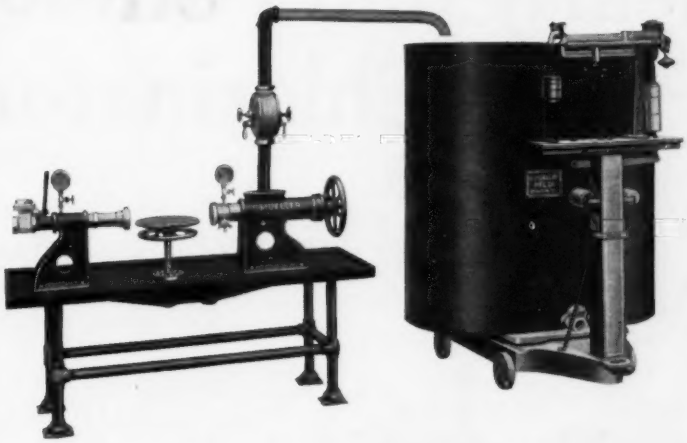
the season of good fellowship is with us. The spirit of Christmas-time is everywhere.

What time then could be more opportune for us to step from the beaten path of business and join in wishing you a Merry Christmas and a successful, prosperous and Happy New Year.

BADGER METER MFG. CO.
Milwaukee, Wis.

Branch Offices:
CHICAGO — KANSAS CITY, MO. — NEW YORK CITY
SEATTLE, WASH. — CINCINNATI, O. — LOS ANGELES, CALIF.

BADGER Water METERS



Are your meters telling the truth?

INCLUDE A METER TESTER IN NEXT YEAR'S APPROPRIATION AND END COSTLY LOSSES ON THOSE UNDER-REGISTERING METERS

For the sake of protecting your city or waterworks against losses on under-registering meters, be sure to include a MUELLER Meter Tester in your 1928 appropriations. A number of meters, under-registering, will lose more honestly earned revenue over a few months' period, than a MUELLER Meter Tester would cost. And, according to statistics, meters are much more apt to under-register than to over-register.

It will be to the interests of your city or waterworks then to be sure to include a meter tester in next year's appropriation. But be sure that the tester which you buy is made by MUELLER of Decatur. The name of MUELLER is already a recommendation to your engineers. And the size and appearance of the MUELLER Meter Tester will inspire the confidence of those who watch the actual testing of a meter.

A MUELLER Meter Tester is simple of operation. It is strongly made; the table is cast-iron with wrought-iron legs, and cast-iron head blocks. This tester is made to test meters from ¾ to 2 inches, and with special equipment, will make tests on 12-inch meters.

Plan now to purchase one for next year—and for years to come.

It will give a lifetime of service, and its cost will be absorbed in the savings you make on under-registering meters.

Write for catalog giving full and detailed description of the MUELLER Meter Testing Machine.

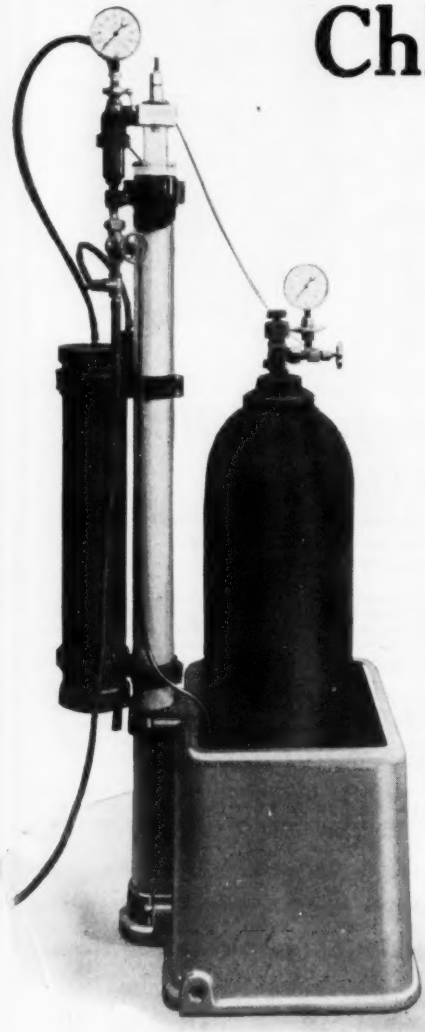
MUELLER CO. (Established 1857) **Decatur, Ill.**

Branches: New York, Dallas, San Francisco, Los Angeles
Canadian Factory: MUELLER, Limited, Sarnia

MUELLER

401

Nearly 600 Paradon Chlorinators



Type TS with 100 pounds cylinder

The first PARADON Chlorinator was installed about three years ago.

Now there are nearly 600 PARADON installations.

This remarkable record is indeed a tribute to the genuine merits of the PARADON Chlorinator—the chlorinator whose cardinal features are simplicity of design, construction and operation.

May we study your chlorination problems?

Send for new bulletin 1-M

PARADON MANUFACTURING CO.

572 Elm Street **Arlington, N. J.**

TRIDENT METERS — LAMBERT METERS

NEPTUNE METER CO. — **THOMSON METER CORPORATION**

Makers of "The Cash Registers of the Water Works Field"

50 EAST 42nd STREET — NEW YORK CITY

WORTHINGTON

Worthington Type G Disk Meter
Furnished with oil-enclosed Monel-metal train gears—a double protection against the corrosive action of water. Also furnished with open train gears.

Worthington Disk Meters

ENCLOSED GREASE TRAIN

For use where water is highly corrosive, full of sediment or turbid. No parts of train except pawl come in contact with flowing liquid. Train enclosure filled with light graphited grease—gives long life under adverse conditions.

OPEN-TRAIN METERS

All gears, pinions and spindles are of natural alloy, non-corrosive Monel metal. Same construction is used in enclosed grease-train meters. Open and enclosed-type trains are interchangeable.

FROST PROTECTION

⅝ in., ¾ in. and 1 in. meters may be fitted with Worthington Frost Clamps on main flange.

OTHER WORTHINGTON METERS

Turbine Velocity Meters; Compound Meters; Hotwater Meters; Oil Meters.

Write for Bulletin W 821 entitled "A Trip Through the Worthington Meter Factory."

PRODUCTS OF WORTHINGTON

PUMPS :: COMPRESSORS
CONDENSERS *and* AUXILIARIES :: OIL *and* GAS ENGINES
FEEDWATER HEATERS :: WATER *and* OIL METERS
Literature on Request

39-7137-4

WORTHINGTON PUMP AND MACHINERY CORPORATION, 115 BROADWAY, NEW YORK
BRANCH OFFICES IN 24 CITIES

1c per 1,000 gallons

Before and after passing through a Permutit Oil Removing Filter. Permutit filtered water is always as clear as crystal, no matter whether the oil is in suspension or emulsion.

to convert oily condensate to Crystal Clear Water!

Condensate is worth from 15 to 20 cents per 1,000 gallons. That is, itcosts that much for the water itself and for the fuel to heat it to condensate temperature. If you have to throw this water away because there is oil in it, you are losing perfectly good money needlessly, because Permutit Oil Removing Filters will transform it to ideal boiler-feed water for less than 1 cent per 1,000 gallons.

These filters are very simple to maintain, and are guaranteed to remove all oil from water whether it is in suspension or emulsion. Frequent shut downs for cleaning or renewals of the filtering medium are not necessary.

The filters are washed out every 24 to 48 hours and scoured every 4 to 6 weeks by turning a few valves, the entire operation requiring less than an hour of one man's time. At no time does the filter have to be opened.

It will pay you to know more about these filters. Send for our booklet, "Saving Fuel and Repairs with Soft Water." No obligations.

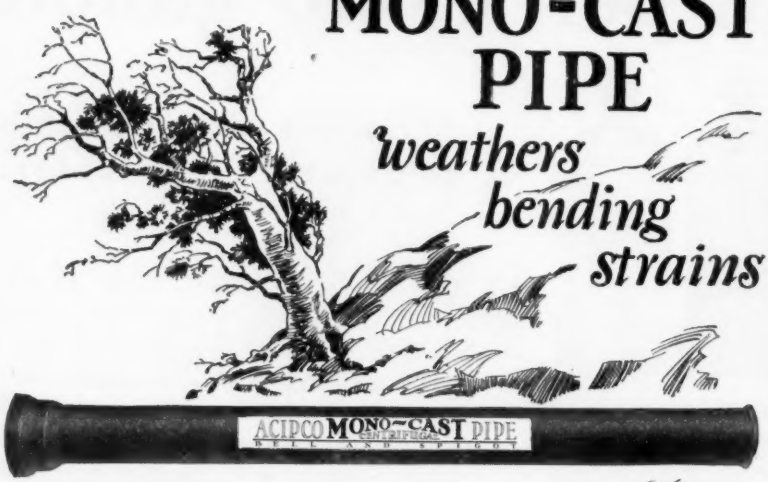
The Permutit Company

Apparatus for Removing Impurities from Water

MAIN OFFICE, 440 FOURTH AVENUE, NEW YORK — BRANCH OFFICES IN ALL PRINCIPAL CITIES

MONO-CAST PIPE

weathers bending strains



FLEXIBILITY and sturdiness have kept this old tree standing for years against strains and stresses that have destroyed its less adaptable fellows.

Flexibility, sturdiness and adaptability to service conditions enable MONO-CAST PIPE to absorb (and thereby withstand) shocks.

MONO-CAST PIPE is flexible and will therefore deliver service for many years.

This "bendability" is but one of the dozen points that recommend MONO-CAST to the thoughtful buyer.

Costs Less to Buy
Costs Less to Lay

More than 2,500,000 feet of Monocast pipe are now in service

AMERICAN CAST IRON PIPE COMPANY
BIRMINGHAM, ALA.

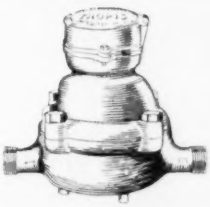
ACIPCO MONO-CAST CENTRIFUGAL PIPE
BELL AND SPIGOT

Machined first - *then* TINNED!

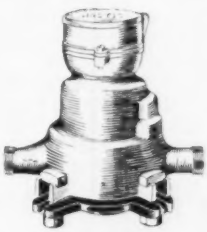
By Hot Dipping Method

BE sure that the meters you buy have working parts that are *machined first* then *tinned*. Meter parts that are machined *after* they are tinned are not protected from corrosion. Where machining cuts away the tin a raw composition surface remains that is not protected.

Every working part of every Pittsburgh Equitable Meter Company Water Meter is protected 100 per cent by hot tinning *after* the part is machined. This process assures longer life of working parts.



TROPIC



ARCTIC

PITTSBURGH EQUITABLE METER COMPANY

PITTSBURGH, PA.

BRANCH OFFICES

New York, New York.
Chicago, Illinois.
Dallas, Texas
Los Angeles, Cal.
Tulsa, Oklahoma.
Seattle, Washington.
Columbia, S Carolina.
Salt Lake City, Utah.
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ADVERTISING

in this

JOURNAL

means more

BUSINESS

DON'T FORGET THE

GET A NEW MEMBER CAMPAIGN

SEND FOR APPLICATION BLANKS

AMERICAN WATER WORKS ASSOCIATION

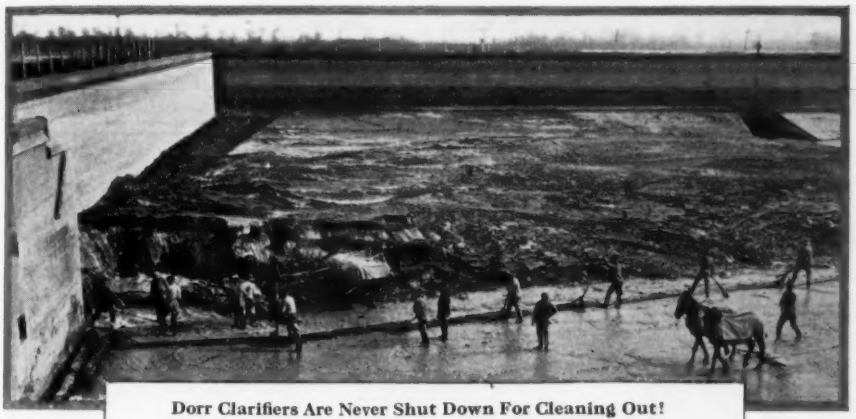
170 BROADWAY, NEW YORK CITY

"Contractors for cleaning water mains.

"A valuable service at a reasonable cost."

General Pipe Cleaning Company

735 Commercial Trust Building
Philadelphia, Pa.



Dorr Clarifiers Are Never Shut Down For Cleaning Out!

St. Louis Selects

Four Dorr Traction Clarifiers for Its New Water Treatment Plant

In the new Missouri River water treatment plant, designed to handle 60 million gallons per day, four 150 ft. Dorr Traction Clarifiers will be installed.

In normal operation two of these machines will be utilized as presedimentation units, to continuously remove the bulk of the solids from the water entering the mixing basins; the other two units will be operated as secondary sedimentation units to continuously remove the precipitated sludge from the softened water which flows from the mixing basins.

The plant is so arranged that the number of clarifiers used for preliminary and secondary sedimentation can be varied, depending on the character of the water being treated.

The decision to install Dorr Clarifiers was arrived at after exhaustive test work had demonstrated that large annual savings could be effected by Clarifier operation.

Send for Sanitary Engineering Bulletin

DORRCO

THE DORR COMPANY

ENGINEERS

247 PARK AVENUE NEW YORK CITY

DENVER
1009 17th St
LOS ANGELES
108 W 6th St
WILKES-BARRE
536 Miners Bank Bldg

CHICAGO
310 S Michigan Ave
ATLANTA
1503 Candler Bldg
JOPLIN
319 Joplin National Bank Bldg

TORONTO 330 Bay St

THE DORR CO. LTD
16 South Street London E C 2

DORR G.m.b.H.
Joachimsthalerstr 10 Berlin W 15

SOC. DORR et CIE.
126 Rue de Provence Paris 8

INVESTIGATION TESTS DESIGN EQUIPMENT

IMPORTANT

THE Association has run short of certain numbers of the Journal. Any members who are not interested in preserving the following back numbers and are willing to return same, will be acting to the benefit of the Association.

January and March, 1920 and 1922
January, March, May, July and September, 1924
All of the 1926 issues.

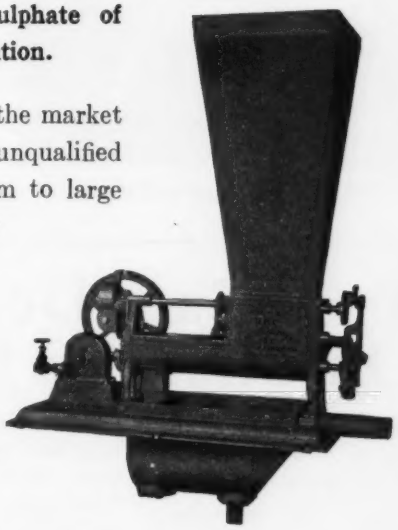
AMERICAN WATER WORKS ASSN.,
170 Broadway,
New York City.

The Gauntt Dry Chemical Feeder

designed for feeding any dry material, especially Hydrated Lime and Sulphate of Alumina for water purification.

These machines have been on the market ten years and have met with unqualified success. We are furnishing them to large and small cities all over the country

Write for Catalog No. 25 giving full description



W. J. SAVAGE COMPANY, INC.
KNOXVILLE, TENN.

Trade Mark

MABBS

Reg. U. S. Pat. Off.

You Can Prevent Wear and Cutting of Rods and Plungers by Using

MABBS RAWHIDE PACKING

LASTS LONGER

Is Anti-Frictional. Saves Power and Money.

Put up in 5, 10, 15, 25 and 50 lb. pails. Price $3.00 per lb.

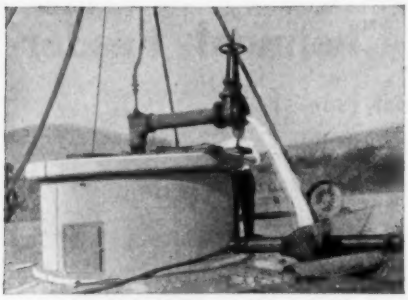
We make a specialty of Rawhide Meter Washers which are superior to cork.

MABBS HYDRAULIC PACKING COMPANY
431 S. DEARBORN ST. CHICAGO, ILL.

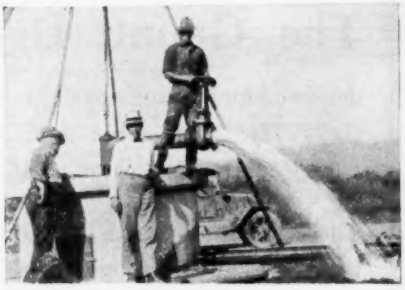
THE WATERPROOF PAINT CO
AQUATITE
HYDRAULIC COATING
NORTH HOLLYWOOD CALIF. U.S.A.

In 1911 Aquatite was a famous ALGAE-CIDE. No moss can grow on your reservoir when this nationally used waterproofing is specified.

Waterproof Paint Company
North Hollywood, Calif.
Convenient shipping points.



Flow from Well Before Backblowing



Flow from Well After Backblowing

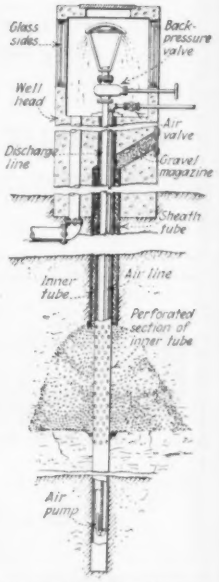
You Can Depend On Shallow Wells

When your shallow well slows up, the trouble is generally "screen choke." There is plenty of water below, but a clogged strainer has reduced your inflow.

"Screen choke" is unnecessary —your shallow well can be made dependable by the "Air-Made Well" process. The sand around the footpiece is pumped out—coarse gravel is put in its place to prevent cave-ins, increasing the collection area and rate of flow to the well, and preventing sand or silt from clogging the screen —thus you are assured a generous water flow as long as there is water to be had.

"Air-Made Well" advantages have been strikingly illustrated at Tonkawa, Oklahoma. Tonkawa is situated right in the heart of a district where "screen choke" has made well after well go dry—yet the city's ten "Air-Made Wells" have *doubled in flow* during the past two years. Tonkawa is only one of many cities where "Air-Made Wells" have solved the water problem.

Your shallow wells, too, can be made to give more water and less trouble. Get the 48 page handbook describing Sullivan Air-Made Wells and Sullivan Air Lift Pumping. It's free to you if you fill out the coupon.



Air Made Well Construction in detail—Note size of artificially made gravel deposit

USE THE COUPON

Send me free 48-page handbook describing Sullivan Air Made Wells and Sullivan Air Lift Pumping.

Name _____

Street _____

City _____

Position _____

SULLIVAN MACHINERY COMPANY
136 S. Michigan Avenue, Chicago

APPLICATION FOR MEMBERSHIP
IN THE
AMERICAN WATER WORKS ASSOCIATION

Date:.....

.....hereby make application for.....

Membership in the American Water Works Association, and enclose herewith the sum of.....Dollars, the required initiation fee and one year's dues in advance.

Name.....

Title or Business.....

Address.....

.....

.....

Business or Professional Experience.....

.....

.....

.....

Recommended by.....

Recommended by.....

Send application to American Water Works Assn., 170 Broadway, New York, N. Y.

(To fill in blank see extracts from the Constitution on other side)

REPORT OF MEMBERSHIP COMMITTEE

We have investigated the qualifications of the applicant, and approve his admission to.....membership.

Date:..... .....Chairman.

Date:..... .....

Date:..... .....

ARTICLE III. OF CONSTITUTION

Section 3. An Active Member shall be either a superintendent, manager or other officer of a municipal or private water works; a civil, mechanical, hydraulic or sanitary engineer, chemist or bacteriologist, including those acting technically as such for, and employed by, Associate Members of the Association; or any qualified person engaged in the advancement of knowledge relating to water supply in general. (Initiation Fee, $5.00; Annual Dues, $10.00.)

Section 4. A Corporate Member shall be a water board, water commission, water department, water company or corporation; national state or district board of health or other body, corporation or organization interested or engaged in public water supply work, and shall be entitled to one representative whose name shall appear on the roll of members and may be changed at the convenience or pleasure of the represented Corporate Member upon written request to the Secretary, and who shall have all of the rights and privileges of an Active Member. (Initiation Fee, $10.00; Annual Dues, $15.00.)

Section 5. An Associate Member shall be either a person, firm or corporation, engaged in manufacturing or furnishing materials or supplies for the construction or maintenance of water works. An Associate Membership shall entitle the holder to be represented by one person on the floor at each meeting but such representative shall not be entitled to vote nor take part in any discussion unless permission is given by unanimous consent of the members present. (Initiation Fee, $10.00; Annual Dues, $25.00.)

Membership in the Association carries also membership in its Local Sections, and the Journal, a monthly publication devoted to water works interest. The proceedings of the annual conventions and of the meetings of the Local Sections are published in the Journal, which also contains contributed articles on subjects pertaining to public water supplies.

ORDER BLANK

MANUAL OF WATER WORKS PRACTICE

This book is the coördinated effort of 300 specialists and presents their accurate summaries of modern water works practice. It discusses collection, distribution, treatment and consumption of water supplies, contains accepted specifications, and treats of water supply problems in relation to the health, safety and welfare of the public.

Cloth, gold stamped, 814 pages, illustrated, price $5.00
(First Edition, September, 1925—Reprinted September, 1926)

The American Water Works Association
170 Broadway, New York, N. Y.

Please send me ..... copy or copies of the Manual of Water Works Practice, for which I am enclosing Five Dollars for each copy.

Name.....

Address.....

Floods Again!

WIDE WORLD PHOTO

THE RAGING CONNECTICUT RIVER—NOV. 1927—BELLOWS FALLS, VT.

—*Are YOU Ready?*

AGAIN a calamitous flood—this time in New England—an area notably free from flood conditions heretofore. Unprecedented rains, continuing hour after hour, swelled brooks to rivers, rivers to torrents sweeping everything before them.

Again the inescapable pollution of water supplies and the consequent dread of typhoid fever and pestilential disease.

Again the call for help—the emergency dispatch on a Sunday evening (seven hours after the call had been received) of a truck load of chlorinators and chlorine and an auto full of our engineers, on an errand of mercy—to combat the germs of disease. A wild, all night ride through driving snow—almost impassable detours because of washed out bridges and demolished roads. A week of herculean effort installing chlorinators, sterilizing water supplies, disinfecting mains, making water safe to drink.

AND AGAIN WE ASK—

"Why wait for the flood?" Any water supply anywhere is liable to such unforeseen pollution as came to New England—as it came to the Mississippi Valley—and as it has come hundreds of times to thousands of places heretofore. To protect against this unexpected pollution, every water supply should be chlorinated regardless of its source.

Chlorination costs but one cent per capita per year. It is the cheapest public health insurance—and the time to provide for chlorination is before the emergency comes.

"The Only Safe Water is a Sterilized Water"

WALLACE & TIERNAN

COMPANY, INCORPORATED

Manufacturers of Chlorine Control Apparatus

NEWARK · NEW JERSEY

NEW YORK CHICAGO KNOXVILLE SAN FRANCISCO MINNEAPOLIS PITTSBURGH DALLAS
KANSAS CITY LOS ANGELES SEATTLE ST. LOUIS BUFFALO HARRISBURGH INDIANAPOLIS
DETROIT WALLACE & TIERNAN, LTD., TORONTO, CANADA
WALLACE & TIERNAN, LTD., LONDON, ENGLAND

SA 10

TRADE **"LEADITE"** MARK

Registered U. S. Pat. Office

Laid 10 miles of water main—and satisfactory in every particular!

—said a waterworks engineer of national reputation, referring to this installation

Here is the story:—

THE Second Taxing District, South Norwalk, Connecticut, U.S.A., has just completed the installation of approximately ten miles of cast iron bell and spigot water mains, varying in size from 6" to 18". The work included the placing of about fifty cutting-in-tees on existing piping and their connection to new work.

Leadite was selected for jointing material after receiving competitive bids for laying with lead.

The total amount of the successful bids for all work, excepting the furnishing of the cast iron pipe, specials and valves, was as follows:

Lead Joints	$155,631
LEADITE Joints	142,535
Difference	$ 13,096
Saving in favor of **LEADITE**	8.4%

The work was performed by contractors experienced in the use of this material and was satisfactory in every particular.

Specifications required that after laying, the pipe should be tested for leakage under water pressures varying from 40 pounds to 115 pounds per square inch, and that the leakage should not exceed two gallons per 24 hours per linear foot of joint. The results of the tests were well within this limit.

This work was under the direction and supervision of Mr. Nicholas S. Hill, Jr., Consulting Engineer, 112 East 19th Street, New York, N.Y., U.S.A.

Leadite is used extensively by thousands of water works engineers, superintendents and contractors with excellent results.

Specify and use **LEADITE** It saves at least 75%

Be sure it is **LEADITE** and accept no imitations

The pioneer self-caulking material for c. i. pipe. Tested and used for over 30 years.

THE LEADITE COMPANY

Land Title Building **Philadelphia, Pa.**

NO CAULKING